HINTS
FOR
PREVENTING DAMAGE
BY
FIRE.

By ALFRED BEAUMONT, Architect,
Surveyor to the County Fire Office.

with the Auditors' Reports

HINTS

FOR

PREVENTING DAMAGE BY FIRE,

IN

THE CONSTRUCTION AND WARMING

OF

BUILDINGS.

By ALFRED BEAUMONT, Architect.

SURVEYOR TO THE COUNTY FIRE OFFICE.

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TO

THE MOST NOBLE

WILLIAM SPENCER CAVENDISH,

DUKE OF DEVONSHIRE,

THIS ESSAY

IS MOST RESPECTFULLY INSCRIBED,

BY

THE AUTHOR.

CONTENTS.

CHAPTER III.

CHAPTER IV.

ADDENDA.

PREFACE.

THERE are no buildings in which security from the risk of fire, or even the lessening of that risk, are not material considerations; but where buildings are the depositories of valuable records, of rare works of art, or of extraordinary productions of nature, destruction by fire is a calamity so fatal and irretrievable, that no pains ought to be considered too great to guard against it.

That the losses which literature and the fine arts have suffered by fire, have not suggested a more general adoption of known means of security than we see resorted to, probably arises from the want of a published collection of information on the subject. The following pages are an attempt to supply that deficiency; and although as a first and somewhat hasty essay, it may not be so full as

may be desired—yet it is hoped that the facts and hints offered, will not be without their use for buildings now in progress, or under consideration, as well as a ground-work on which others may ultimately raise a complete system.

Immediately connected with the safe construction of buildings are the means used for warming them. Upon this subject, a method of generating and economizing heat is described, which has been for several years in use at the County Fire Office, with the most complete success. By this mode, buildings may be effectually warmed with a twelfth part of the fuel usually consumed for that purpose, in furnaces for raising steam, hot water, or warm air, with much less cost of apparatus, and free from smoke, dirt, dust, and every impurity. The contrivance is particularly adapted for the warming of all churches, chapels, halls, large school-rooms, gaols, and hospitals.

HINTS

FOR

PREVENTING DAMAGE BY FIRE,

&c.

CHAPTER I.

The public buildings of the Romans afford the best examples of fire-proof construction, as well as of durability—Their domed temples and arched chambers still exist, although repeatedly subjected to fire—Peculiar excellence of their bricks and mortar—The arch, and vaulted roof unknown to the Greeks and Egyptians—After the overthrow of the Roman empire only wood and thatched buildings were raised until the ninth century—The pillars, arches, and vaulted roofs, called Saxon, a coarse imitation of the Roman—The walls, and vaulting of Gothic buildings are very durable and secure from fire—Timber framed buildings—Insecurity of modern brick buildings—Brick-nogging, bond-timber, and quarter partitions, a modification of the old timber-framed houses—Daily firings—from timber laying near, and in, flues—from bad brick-work—from discharging pieces in chimney breasts—from trimmers and plugs thrust into flues—from battened walls—from strong fires in common flues—from pockets and vacuities in brick-work—from combustible rubbish in setting grates—from flues run up—for hot plates, coppers, and hall-stoves, against contiguous timber—from iron smoke-pipes—from descending flues—from gas—from the carelessness of workmen.

Whatever superiority we may claim over the ancients in intellectual improvements, in the general diffusion of knowledge, and in the application of science to the *useful arts;* in the *fine arts* of architecture and sculpture we are confessedly very much their inferiors. In purity of design, strength, durability, and in

safety from fire, their buildings are incomparably better than those of modern date. In design, we are content to take our best lessons from the ancients; and we propose to show that, with equal profit, we may follow them in obtaining the comfort of warmth for our habitations.

The public buildings of the old Romans still remaining, offer the best specimens of fire-proof construction, as well as of general durability, of which we have any knowledge. Although repeatedly fired, battered, and destroyed, as far as the efforts of barbarous enemies could effect their destruction, numerous portions of buildings, and some entire temples and mausoleums, still remain to attest the superior construction of the ancient over modern buildings. The portico to the baths of Agrippa, now the Pantheon, and the mausoleum of Hadrian, now the Castle of St. Angelo, are admirable instances of the strength and durability of their circular buildings with domed roofs; while the magnificent halls in the remains of the baths of Titus and Dioclesian, and the golden palace of Nero, are equally valuable specimens of oblong buildings with arched roofs. The walls of these buildings have the strength and solidity of natural rock; most frequently they are composed of two facing walls of brick, a brick in thickness, leaving an interval between them, which is filled up with coarse grout-work: sometimes the facing walls are composed of small pieces of tuffa (a free-stone): these walls have been occasionally faced again with fine marble. The walls of some of the principal buildings are composed of immense squared blocks of travertin (a porous marble of the country). The bricks are invariably sound and hard; their shape the large flat tile, the work with which is less liable to give way and bulge than with bricks of the modern shape. The mortar is perfect, and the joints completely filled: the grit of the mortar appears to be pounded tile, or tuffa, always sharp and clean; and the grout-work consists of broken tiles, and sometimes tuffa, embedded in mortar of the usual thickness, not flooded with a fluid mortar approaching to whitewash, as is now in use under the name of grout. That the mortar was not used in a fluid state, is visible in numerous fragments where small interstices are discernible, shewing the shape of squeezed mortar. The

peculiar strength of the Roman mortar is remarkable.* In most cases, the Roman walls are constructed like the trunk of a tree, broadest at the root and diminishing upwards, and, as is well known, when they raised their walls with grout-work, they usually ran a double layer of their large tiles over their work at the height of every two or three feet.

In consequence of the care thus bestowed on the solidity of their brick and grout-work, it is one compact mass; and when a fracture does take place, it is not a separation of entire bricks from crumbling mortar, as with us: their adhesion remains intact, but it is a splitting of the mass, as that of one entire rock: the marble encrustations or inlayings on their walls gave way to the effects of the immense fires which were lit within as well as without the buildings; their marble columns were scathed, and their surfaces, reduced to lime, were splintered off by the fires, but the brick-work has remained sound to this day. The accretion of ashes, of rubbish, and of decayed vegetable matter, during fourteen centuries of desolation, caused these buildings to be wholly or partially buried in a new soil. Even now the plough passes over the roofs of several of their imperial halls, but as the rubbish within them is excavated, their structure is found unimpaired; they are without fissure or fracture; and, in some of them, the fresco painting on their stuccoed interior is as fresh and unbroken as if it were but lately come out of the hands of the artist.

The buildings of ancient Greece had not the fire-proof merit of the Roman buildings, as the Greeks were unacquainted with the art of raising vaulted roofs, or even common arches. The stone or marble roofs of their principal buildings were supported by massive timber framing, which were frequently

* This is not a place for discussing the different opinions on the causes of the strength of the Roman mortar or cement. The most probable seems to be that their lime was made from marble; that they did not use it slaked, but reduced their quick lime to powder by crushing it; and that they applied it as soon as wetted. This seems the more likely, as the mortar in the grout-work appears a more perfect concrete than that used in the joints of their brick-work, which, it may be supposed, was in great part used, after the natural heating from the first wetting had subsided, and the strong crystallization which would then begin had been disturbed.

destroyed by fire; their walls, however, constructed of solid masonry, and of exquisite workmanship, remained, and the buildings became restored to use upon the putting on of new roofs. These roofs are now wholly gone, but the magnificent columns and the admirable masonry of the walls of their temples, have in great part withstood the battering artillery of successive conquerors, which, more than fire or time, has caused the dilapidations we so much deplore.

As the Greeks drew their knowledge of building from the Egyptians, it is not to be supposed that the Egyptians understood the art of raising vaulted roofs; their public buildings remaining seem to consist of extensive ranges of columns covered over with immense slabs of granite. In their temples of Philae and Edfon, some of these slabs measure eighteen feet in length, five in width, and three feet in thickness. No traces remain of their brick-work, nor is it likely that there should, as their bricks had no other baking, it may appear, than what the sun gave them. At Babylon similar bricks were in use, and may, in some parts, be yet distinguished, but in general they have mouldered into unshapeable lumps of earth; and the ruins of that great city are with difficulty recognized, in heaps and ridges of that material. No traces of vaulting or arches have been discovered in Egypt, Syria, and neighbouring countries.

During the dark ages which followed the destruction of the Roman empire, the insecurity of property forbade all building for posterity; timber, mud, and thatch, appear to have been the materials chiefly used, not only for habitations but for churches throughout Europe, until about the ninth century; architecture then became cultivated (among the monks,) and religious buildings and the castles of chieftains were erected in a substantial manner. The forms and construction of the Romans were then imitated, and the inferiority of their workmanship to that of the Romans was endeavoured to be compensated by additional massiveness. Hence the extraordinary thickness of the columns called Saxon, and the security used to prevent the spreading of their walls by large buttresses. Like the Romans, they built their walls with solid masonry of squared stones, and also raised them with grout-work; but the masonry had not the

largeness of blocks, nor the accurate squaring, of those of the Romans; nor their grout-work the strength of the Roman cement; nor was brick-work much in use until towards the close of the Gothic period, viz., about the middle of the sixteenth century: still the architecture of the middle or Gothic ages had always an especial regard to solidity and durability. The lower floor of their principal buildings was generally vaulted with stone, and perfectly fire-proof. The ancient crypts of their religious buildings are always found entire, although their superstructure may have suffered many changes from conflagrations. In the recent destruction of the Houses of Parliament, although the interior of St. Stephen's Chapel burnt with uncommon fierceness, owing to the large quantity of floorings, galleries, benches, wainscotting, and other fittings of wood within it, the fine stone vaulted chamber beneath, used as the Speaker's dining room, remained undamaged. In the firings of Gothic buildings generally, as with the Roman, we may observe that although the combustible parts within them are consumed, the walls generally remain sound and as useful as ever for the reinstatement of the interior and roof of the building. This has been exemplified by the celerity with which York Minster was restored, after the destruction of its interior and roof by an incendiary. For many centuries preceding the three last, our buildings, with the exception of the religious, and the castellated ones, were constructed of framed timber-work filled in with lath and plaster, or loam, and latterly with brick. The same sort of construction is still in use for inferior buildings and interior divisions, under the name of brick noggin or brick panelled, and quarter partitions, and even in the main walls of first-rate buildings, the old dependence on timber framing is adhered to, in the modification of tiers of bond timber, and wall-plates. This sort of tie is necessary to keep our fragile brick walls together; but when a fire happens that tie becomes lost, and if the brick-work does not tumble to pieces, as it usually does during the fire, it is generally so shaken by the loss of its timber supports, as well as by the feeble adhesion of the mortar, that it cannot be reinstated by the insertion of new timbers, but has to be taken down. A fire, therefore, which, in

a building with sound and incombustible main walls, would only occasion a partial damage, causes the total demolition of a building with walls insufficiently sound and strong to support themselves without the aid of timber.

In the erection of *modern buildings* there is generally found an impatience for speedy finishing and enjoyment, which is incompatible with durability and safety from fire. Unlike the ancients, and our Gothic predecessors, we do not build for posterity, we build for ourselves alone. Not to endure for centuries, but to enjoy, or sell, as soon as possible. To put on a good appearance of strength and durability, but to disregard the reality, where any expense can be saved by so doing, is no more than might be expected from builders on speculation: but modern practices are unfavourable to sound and safe building, even when the buildings are superintended by able architects, and raised for opulent proprietors. The general use of fir for all timber and boards, in lieu of oak, elm, and other woods, which are little combustible, as well as the dependence on bond timber for tying the walls together, conduces to the risk of fire, and to its destructiveness when raised. In particular, the placing of fir timbers in or near furnaces, fire-places, and flues, is a daily source of conflagrations.

Generally it ought to be borne in mind, that fractures and cracks in ovens, and furnaces, and their flues, are sure to happen sooner or later. The continued action of strong fire on common mortar destroys its quality; it loses its tenacity, it becomes friable, and decreases in bulk. Hence the bricks fall in from the roofs of ovens; and settlements are always observed in old furnace flues; but sometimes these settlements are visible very early. Wood, (particularly if it be fir,) which is laid within a few inches of these heated fire-places and flues, becomes as dry and nearly as ignitible as tinder. In a common flue a fissure within it is filled with soot, and it would only be on a firing of the soot in the chimney, that the soot in the fissure would take fire; but it then would burn, and if the fissure communicated with contiguous timber, that also would take fire. This firing of hidden timbers frequently goes on mouldering for days before it is discovered; when at length meeting a part

where there is an accession of air, it bursts out in a flame. As this sometimes takes place at some distance from the flue, the cause of the fire is not recognized, and an unfounded suspicion is raised that the firing has been intentional. Hence the propriety of sending a chimney-sweep through a chimney that has been recently on fire, to endeavour to discover whether there are any lodgments of burning soot remaining in the flue. When a fissure occurs in the body of the furnace, or the part of the flue which is near to it, the strength of the fire will prevent any accumulation of soot within it, but whenever the fire reaches through such fissure to any contiguous wood-work, that wood will to a certainty be fired. The danger is much increased if the train reach a deposit of shavings between the joists. It is very common, but not the less shameful, for workmen, when laying a floor or finishing round it, to cover over their shavings rather than be at the trouble of removing them. Nothing can be more adapted for raising a fire; a spark dropping through the cracks of a floor, may be enough to fire a house where such combustibles are laid. It sometimes happens that wood embedded in brick-work, and fired from a flue, after burning to a certain extent, goes out; the force of the fire acting on it reaching no further, and there being no air to feed the combustion of the wood: charred pieces of timber, which had been evidently fired from an adjacent chimney, years before, are sometimes discovered in taking down old buildings: These cases, however, are exceptions. The rule is that timber fired from a furnace or flue, involves the destruction of the building, unless stopped by timely exertions.

One of the most fruitful sources of accident in common buildings in the country is, *a bearer of wood* for the chimney breast; this ought always to be of iron; for cheapness, a bit of wood is used; and when it fires, which it seldom fails to do at one time or another, the Insurance Office is required to make all good, and, to prevent a recurrence of accident, the office is expected to supply the iron bar, which the builder was too parsimonious to provide. This is neither fair nor legal. Then, as if courting conflagration, timbers are laid close to flues, and sometimes even within the flue itself. The mortice pecked in

the four-inch front of a flue to receive the bird's mouth end of the small hearth trimmers, and also the plugging for grounds, frequently break into the flue and ensure a firing of the house the first time the soot takes fire. Trimmers, joists, rafters, and girders, protruded through the sides of flues, and even when lodged against the sides of flues, occasion numerous accidents.

These dangerous errors in building are now in some measure corrected in and about the metropolis, by the provisions of the Building Act; but in the country they are still committed by negligent builders with impunity. There are some causes of danger, however, that can hardly be provided against by any legislative rule. One of these results from the power of igniting wood, which extends through brick-work where an intense and continued fire is raised. We have known a house to be set on fire by the heat of a furnace, although there were eighteen inches of solid brick-work between the (stove,) fire, and the wood. This was precisely the case at Messrs. Perkins and Heath's stove, in Fleet Street, seven or eight years since: it set fire to the timber of an adjoining house in Water Lane.

As the precautions taken by builders in general, when any are used, for placing their wood-work out of the reach of fires, in ordinary buildings, have only in view the fires within ordinary chimnies,—and as the Building Act requires no more,—it is not surprising that when a flue in a common dwelling is applied to the purposes of a furnace, a close stove, or of a very powerful open fire, that such excessive fires should reach the timbers, and cause conflagrations. This risk is very much increased, when the walls are battened and lathed; because settlements and extensive fissures may then take place without being discovered, and the battens and laths are fearfully adapted for the extension of a fire; whereas had the stuccoing been on the solid brick-work, the fissures would have been seen, and *stopped up* from time to time, as they appeared, and there would be *no combustible covering* to communicate a fire through them, and from one floor to another. Frequent fires burst out just after unusually large fires have been in use. The recent destruction of the two Houses of Parliament, is attributed to certain workmen firing an

excessive heap of slips of deal, to consume them more speedily. It is in evidence, that excessive heat and much smoke in the House of Lords, were remarked upon for some hours before the fire broke out. The fire was evidently, at that time, making its way behind the wainscotting unseen. This, and similar awful calamities, ought to teach persons the impropriety of raising intense fires, in fire-places and flues not constructed to receive them; but if unusual fires be raised, they ought, at the least, to be extremely vigilant in noticing whether any smoke or smell denote the firing of adjacent wood-work, that timely exertions may be made to stop its progress.—The danger from fire, and the instability of brick-work, are greatly increased by a practice among scamping workmen, of leaving hollow places, called pockets, in their walls; and in using only so much mortar, in laying their bricks, as gives a fair joint to the eye, leaving all behind hollow. The hollows get filled with soot, and when a fire takes place in an adjacent flue, the sooty chinks form a train which sets the building on fire. There is no legal penalty against this shameful fraud on the employer or house purchaser. A minor cause of alarm sometimes arises from the setting of block chimney-pieces, in such manner, as to leave a communication between the hollow of the chimney-piece and the flue, in which hollow the soot gathers, and at length takes fire; but a more frequent cause of the same kind consists in the grate being set hollow behind. In this receptacle the soot falls and collects, for a length of time, until it reaches the middle of the grate, when, upon the back becoming red hot, it lights the heap, and produces such an intense fire as to endanger the adjacent wood-work. Another mode of doing mischief arises from filling up the space behind the grate with combustible rubbish—cinders, ashes, and coal, from the dust-bin; and the workmen's sweepings, if any, including shavings, and pieces of wood, seldom come amiss to the bricklayer, so that they are near hand. We were called to a raging fire at the back of a register stove, on one occasion, when, upon removing the grate, it was discovered, that the whole vacancy behind was filled up with several bushels of simple unadulterated coals. Upon inquiry, it turned out that the bricklayer having been referred

to the dust-bin for rubbish, and finding it empty, had directed his Pat to basket away from the coal cellar!

Firing from *alterations in flues*, and *additional flues* erected in old buildings, are very common. The workmen must be, of necessity, somewhat in the dark, as to the precise layings of adjacent timber; but the indifference with which they disregard the contiguity of timber which they see, or know of, is frequently remarkable. Additional flues, to communicate with the kitchen flue, are continually required for hot plates, boilers, and ovens, and a slant of six or eight feet in length, generally forms the connexion with the kitchen flue; but to make the projection as little unsightly as may be, as well as to get a support for the work, it is common to cut a chase in the wall. In doing this, the bond timber is frequently laid bare, but many workmen are so culpable as to make this exposed timber a side of their flue, or if they dab over it a bit of tile or slate, it is deemed an ample sacrifice to prudence. But the fires in these furnaces, and the short flues from them, are very powerful. They are sure to fire adjacent woodwork, unless a sufficiency of brick-work intervene.

Iron stoves set on a wood floor, and having iron pipes, are always more or less dangerous. It is thought enough to have a sheet-iron fender to set the stove on, or if an additional sheet of iron, or lead, or slates, be placed between the fender and the boards, it is deemed being particularly careful; but more is necessary to be secure. We must look forward to some one taking the burning coals out of the stove, and putting them on the iron plate below the stove. These coals may burn fiercely, and as the boards underneath will be dry and hot, a little fire will ignite them. The iron pipes to these stoves are full of danger, unless they are carefully attended to. When they are not in use, particularly if much soot be left in them, they attract moisture, and are rapidly oxydized. Then, when they become filled with soot, and the soot takes fire, it burns fiercely, and the fire drops through the rust holes and the joints; and if these droppings of fire occur between a wainscotting or a battening and the wall, at the hole where the pipe enters the brick flue, it is likely to set the house on fire. This

danger is more imminent if the pipe passes through a floor, or lath and plaster partition, unless due precautions are used; and when the pipe is carried over goods that might take fire, if a spark falls on them, the hazard is considerable.

Descending iron flues, from open fire-places in cast-iron stoves, set up in shops and halls, are productive of frequent firings, whether they are conducted through the floor and along the building of a room beneath, to an adjacent chimney, or are carried between the joists to such chimney, or just over a wood floor, they are full of danger; but the hazard of running them between the floor and ceiling is the most imminent and unwarrantable. Say what they may of surrounding the flue with incombustible materials, no fire-flue can be made safe, within a few inches of wood-work. It is pretended by some of the vendors of these dangerous and expensive stoves, that they burn their own smoke. They do no such thing. They carry away their own heat; and as a stronger fire must be used to force a draught through a descending than an upright flue, more smoke is raised, and the heat is more rapidly carried away, through such stoves and flues, than from a common grate or close stove. They wear the look of warmth to the eye, but deny the reality of warmth to the body. They are expensive in themselves, wasteful of fuel, and productive of dirt and danger.

Gas is, perhaps, less likely to cause the firing of a house than lamps or candles, because they have no droppings of sparks or snuffs. They are, however, more apt to fire light things, carelessly hung over them, than lamps or candles; but this may be guarded against by glass bell covers, which have the further use of causing almost the whole of the smoke and noxious effluvia to be consumed; but, when accidents do happen from gas-lights, their effect is immediately visible, and is generally extinguished before much damage is done. But there is a peculiar danger from gas, which is the cause of frequent and destructive accidents. This arises from suffering an escape of gas, while a light is left in the same apartment, and the apartment is closed. In this case, the gas ascends to the ceiling, and as it accumulates there, it drives the atmospheric air out at the door crevices and up the chimney, until the accumu-

lation of gas descends to within reach of the light. A violent explosion then takes place, and if the contents of the place are ignitible by a sudden flame, a fire, also, is the consequence. This has been detected to have been done wilfully, to raise a fire for a fraudulent purpose. When a fire has got a-head, the pewter gas-pipes melt—a gas-meter may do the same. The volume of gas, which then pours from the gun-barrel pipe, during the progress of the conflagration, adds fearfully to the mass of fire. It is equal, in effect, to an engine playing a stream of oil on the flames.

One of the most frequent causes of the destruction of large buildings by fire, still remains to be noticed. It is the excessive carelessness of workmen, employed to raise or repair them. The destruction of the greater part of public buildings by fire, has been traced to the CARELESSNESS OF WORKMEN. Workmen raise fires, in the most convenient places for themselves, to heat their glue-pots, or their irons and solder. As they are not paid for looking after the safety of the fires, no one seems to consider it his particular business to bestow any care upon that subject. Their affair is to get their tools heated—that done, or the hour of repast or rest arrived, the fire is no more thought of. The fire may fall from the grate, or be blown from it, among shavings or chips—no one cares. What is every body's business, is nobody's.

From these remarks on the causes of fires, arising out of defective construction in buildings, as they now are, and carelessness, we will turn to consider the means, by which such disasters may be prevented or lessened in their effects.

CHAPTER II.

Remedies proposed—Prohibition of timber in party walls, or at least within fourteen inches of a flue—An improved brick-work, hard bricks, and strong mortar, only—No pockets or vacant chinks to be suffered in party walls—Corbels and iron ties to be used for the support of timber near flues—Stuccoing instead of battening and lathing the walls—Stone stairs—Precautions for furnace chimnies—For iron smoke-pipes—Against accidents from gas—Against carelessness in workmen.

A most important service to the public has been done by the Metropolitan Building Act. The great object of that act was to limit the destructive effects of a fire to the premises in which it broke out, and to prevent its happening there, as much as might be, by enforcing precautions against fire in the construction and repairs of buildings. To a very great extent this object has been accomplished; since this act (in the year 1774,) commenced operation, the greater part of the metropolis has been either new built or rebuilt, and therefore we seldom hear now of a fire extending beyond the house in which it broke out, unless the house be a very old one, and never, as formerly, of two or three hundred houses being involved in one conflagration. It is a great point gained in the way of security, for a man to know that he is fire-proof against the risks of his neighbours to the right and left, by virtue of his party walls. This comfortable reflection he might confidently enjoy in perfection, and he might add to it, that he had also nothing to fear from a fire happening within his walls from his own fire-places, if those walls were made as sound as they ought to be, and free from timber. But it has been too much the custom to run up party

walls with place, and shuffy bricks, and with mortar composed of weak chalk-lime, and an excessive proportion of sand or road sweepings, and as much dirt as can be shovelled up with it.

The public and the profession are indebted to one district surveyor, Mr. Foxall, for having resolutely done his duty, in condemning party walls constructed with place bricks. It is now ruled that place bricks are not sound bricks, within the meaning of the act. But in order to ensure soundness and strength in party walls, we must have sound mortar as well as sound bricks; nor ought a builder to be suffered to evade the laws, by making the party walls hollow with a range of useless flues, although one or two spare flues are desirable, and ought to be allowed: still less ought he to be suffered to put the bricks together with a mere pointing of mortar, as is often done: The whole of the bricks ought to be sound and hard, the mortar strong, the lime from stone, the sand coarse and clean, and the water clean. If the bricks are dry, to ensure sound work they ought to be separately dipped in water at the time of laying, and not a chink about them ought to remain unfilled with mortar. The whitewash, called grout, sometimes poured over the work, is far from improving it; if it were applied before the bricks were set, there would be some good in it, but swam on afterwards, it is apt to wash away the adhesion of the mortar, and to fill the wall with humidity without any corresponding advantage.

No timbers ought to be laid in party walls if it can possibly be avoided: in ordinary dwellings it is not absolutely necessary to disturb the party walls at all, by the insertion of timber. The bond timber of the front and back walls might be returned in the party walls with iron ties. By the present usage of fixing the trimmers for the hearths, and well of staircase, in the party walls, that part of the wall which is hollow with flues, is most perforated with the ends of timbers; and the timbers (trimmers) frequently break into the flues themselves, whence communications are made between the flues and flooring-joists, which cause the firing of many buildings. But this might be obviated with very little additional trouble. Bits of stone (of York cill), in the manner of corbels, might be worked up in the brick-

work for the trimmers, and the bearers for stairs to rest on; and if a tie to the wall be necessary, it might be managed, it is conceived, by screwing a bit of iron plate, one-eighth of an inch thick, one or two inches wide, and eighteen inches long, with a turn up at the end, to embrace the length of a brick laid above it. Be this managed as it may, however, if there be not an unqualified prohibition of timber in party walls, at any rate no timber ought to be suffered to be laid into a party wall within fourteen inches of a flue; we say fourteen inches, that the failure of a single brick may not be sufficient to cause a communication from the flue to contiguous timber; nor ought a party wall to be suffered to be mutilated.

It is quite necessary that the party wall should be carried through the roof, and this ought to be as much as eighteen inches, or it cannot be depended on; carrying up to the tiles or slates will not do. If any wood goes over the party wall, there the fire will go also, for the strongest action of a fire is against the roof so long as the roof remains. We have continual instances of the inutility of party walls, unless they go through the roof. Some consider the projection of the party wall above the roof unsightly; but this is a mere prejudice; the projection is necessary, and is additionally useful by shewing assistants, in the event of a fire, the precise spot where they may reckon upon a stop being made. Nearly as much mischief is done to goods, and even to a building itself, sometimes, by the means used to save them, in the uncertainty how far a fire may extend, as the fire would have done had it reached them; and this where there need have been no fear, if the party wall could be depended on.

But to ensure the soundness of party walls, and their security from the dangerous laying of timbers near flues, some further legislative provisions are necessary. The Building Act is an excellent and comprehensive measure, but means are wanting to give effect to its objects. It is not enough to appoint district surveyors; they cannot be on the spot to watch every unsafe act or neglect, if ever so well disposed to extend their services beyond the collecting of their fees. But if penalties were imposed upon disregards of rules for safety,

against any one causing such disregards, whether principal, surveyor, builder, or workman,—half the penalty to be given to the informer,—each party would be a check on the other, and each would fear to commit the offence, knowing that it would put him in the power of the other, and that that other would have a motive to accuse him: a further security might be obtained, by making the offender liable for all consequences to a sufferer, should a fire result from his misdoing or neglect in building.

In modern buildings a great deal has been done to lessen the risk of fire by the disuse of wainscotting, and, in the better sort of houses, by the more general use of stone stairs. Indeed, if it were not for the battening and lathing of the walls for the more hasty decoration of a building, and the introduction of lath and plaster quarter partitions, it might now be difficult for a fire happening on one floor to reach to another.

If, instead of lath and plastering on battens, the plastering or stuccoing the walls be on brick-work only, the brick-work being dubbed out when necessary, besides being much the sounder work, a fire happening on one floor could only reach the next above it by the door and window-frames, and architraves, and by the furniture in the room, the firing of which, in most cases, might be subdued with common exertions. Battening and lathing the walls is an expedient to enable the builder to paper and finish while the walls are yet wet; which moisture might continue to ooze through for a twelvemonth, if the plastering were on the brick-work. This difficulty may be got over, however, by the use of Hamlyn's oil cement, manufactured by Francis and White, at Nine Elms. This is a firm stucco, which effectually resists the transmission of moisture, but it is rather more expensive than common stucco, viz. 4*s*. 6*d*. per square yard.

If the stairs be built of stone instead of wood, the most destructive arm of fire, viz., the staircase, will become the best means for the preservation of life, if not of prevention of fire; for the strong draught, and the combustible material of a wooden staircase, are the most immediate and powerful agents in spreading a fire throughout a building, and of cutting off the

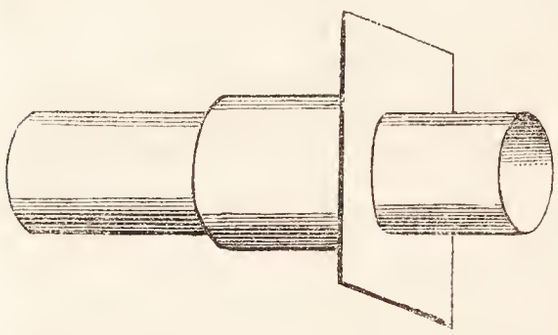
inmates from the means of escape. In illustration of the rapidity and fierceness with which a flame rushes up a staircase, we may be allowed to mention an instance that fell under our own observation: some years since a fire happened at a large house in Chandos Street, owing to a quantity of shavings that had been made by workmen in the kitchen. The fire soon flared out, after just lighting the kitchen door, and the kitchen balusters; this was easily subdued; but after all was quiet, there was an alarm of a fire in the attic: it turned out that the door there was actually on fire from the flame in the kitchen. An unseen draught of flame had rushed up the staircase, fifty feet in height, just slightly blistering the paint in its progress, until it reached the roof, where, being obstructed by the ceiling above, it reverberated, and so acted upon the door of an attic as to set it on fire. Had the flame been stronger, or had it continued ten minutes longer, the whole staircase would probably have taken fire, when nothing could have saved the house.

There ought to be a considerable thickness of brick-work, or of other incombustible material, between the inside of a furnace and its flue, and contiguous timber:—that thickness ought to increase in proportion to the intensity and continuance of the fire. It is difficult to reduce this to a specific rule; but for a furnace that works night and day, two feet is scarcely sufficient. The settlements and fissures, which are, sooner or later, observable in all settings of furnaces and their chimnies, indicate the expediency of setting the bricks which are nearest the fire, in something less consumable than common mortar; and, also, the necessity of not resting any timber in, or against them. If a strong bearing must be had on the wall of a furnace or flue, it ought to be on a stone corbel projecting from it—if a slight bearing, an iron hook may do; but in all cases, unless the wall be very thick and sound, no timber ought to be in contact with it, not even to bear against it. Joists and rafters ought always to be trimmed free from it by two inches.

German Stoves of Iron, so much in use in manufactories, ought always, when placed over a wood flooring, to have a flag stone underneath, with a secure rim round it, sufficiently large

to receive any hot cinders that may fall out, or be taken out, of the stove, and there ought to be a sheet of lead under the stone.

Iron Smoke Pipes.—Wherever these pass through a quarter partition or flooring, or a wainscotting or lath-plastering, into a brick chimney, the hole ought to be something more than an inch in diameter larger than the pipe. Then get a tinned plate, with a hole in it just large enough for the pipe to go through; and get another short pipe or rim of tin, a little more than long enough to clear the ceiling or partition, and about an inch more in diameter than the smoke-pipe, which rim rivet to the plate, so as to leave half an inch, or more, all round the hole in the plate. This plate and rim, fixed to any hole through which the iron pipe passes, will protect the partition from any droppings of fire from the smoke pipe, and from the pipe itself, should it become red hot.



Another necessary precaution is, to *prevent a large accumulation of soot in these tubes.* By cleaning them often, they will transmit much more heat, while they avoid the danger of raising a strong fire upon ignition of the soot. As soon as the fires are done with, the pipes should be well cleaned out, and the draught through them closed, until they are again wanted. This will retard their decay through oxydization, which goes on more rapidly when they are laid by, than when in use. A third precaution is, not to place any goods over the pipe, which, by falling on it, might get on fire. In some stove rooms, in the north, where these iron stoves and pipes are used, we have seen them covered with a flooring of perforated tiles of earth or metal; also of iron grating. In some other places, a screen of wire-work has been placed over these pipes. And, when these precautions are applied with judgment, and looked after with care, there is not much to fear from these very effective (for heating), although dangerous and unwholesome stoves. A precaution is also necessary, when the iron pipe passes *over* combustible materials. This is frequently the case in workshops. To avert the danger to be apprehended, if the soot takes fire from the

dropping of burning soot through holes or joints, or of the pipe itself, a tin trough, about ten or twelve inches wide, may be suspended close under the pipe. We had a precaution of this kind, fixed under a large iron pipe, in Mr. Bullock's Panoramic Exhibition of Natural History, at the Egyptian Hall, some years since, and we were informed that the soot did take fire in the pipe, and that some of the fire fell through into the trough, which but for it would have fallen on the dried moss beneath, and probably have consumed the building.

The danger of gas in a building, whether from leaving a cock open in a close apartment, in which a light is left, or from the melting of the pewter pipe, should a partial fire take place, can only be guarded against by having a cock on the iron or gun-barrel pipe, in a place easy of access; and to make it an invariable rule never to put out the lights by turning the cocks at the burners, but by turning the cock on the gun-barrel only. If there be a gas-meter on the premises, that cock ought to be between the meter and the street. If there be not a place there where it can conveniently be got at, the cock may be put (with a handle to take off) outside the premises. Indeed, at theatres and large manufactories, this is pretty generally done; but when this precaution has not been made, or it is suspected to have been neglected, and the building be on fire, and apparently is fed by the gas, it is proper to stop the communication by breaking the gas-pipe outside the building, and plugging it up.

Carelessness of workmen.—Whenever a building is going on, in which workmen raise their own fires, one person ought to be especially appointed: 1st, To be consulted as to the place where fires may be lit. 2nd, To see that no shavings, or other combustibles, are collected about them. 3rd, To watch them when the workmen are at meals, and to see that they are extinguished when they leave for the day. Accidents also happen, although much less frequently, from coke or charcoal fires in braziers, placed in the middle of rooms to dry the walls. These, also, ought to be frequently looked after. The floors will seldom escape injury, unless a piece of sheet lead, four to five feet square, be laid under each brazier.

From these remarks, on remedying defects and risks in buildings as they usually are, we proceed to the consideration of that more secure method of building, which is growing into use, under the denomination of Fire-proof.

CHAPTER III.

Methods of constructing buildings fire-proof—Party walls a valuable protection from lateral risks—Incombustible ceilings an equal protection between floor and floor—Common brick vaultings effectual—Brick arches, in serics, sprung from iron beams—The method of construction described—York landings in iron bearers—Iron doors—Iron roofs—The fire-proof principle may be adopted, with economy, in various hazardous trades, and depositories of valuable property—May be partially adopted, with good effect, in all extensivc buildings—Might have limited the destruction of the Houses of Parliament to a small extent, had it been provided—Different modes of fire-proof combined at the County Fire Office.

Sound and strong party walls, carried through the roof, are an important advance toward fire-proof construction. To limit the ravages of a fire to a space between two party walls, is the first step :—the next step is, to confine it between floor and floor.

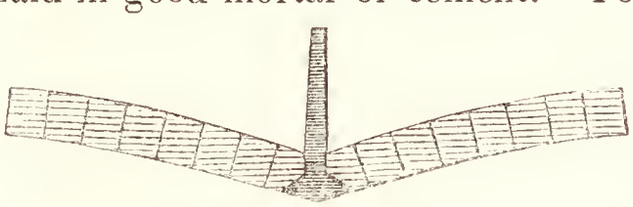
Incombustible floors and ceilings are procured conveniently where the bearings are short, (*i. c.*) do not exceed six or seven feet, as in passages and small apartments, by the use of York landing stones ; but they are not to be depended upon if a very strong fire happen immediately under or over them. This covering has a faint resemblance to the slabs of granite coverings of the Egyptians. Semicircular or elliptical brick arches, springing from substantial brick walls, in the manner of the Roman works, is the sort of building most to be relied on against fire and time ; but when these arches are *large*, they have a tendency to push out the walls which support them, which must be counteracted in one of three ways : viz. the

supporting walls or piers must be very massive and cohesive, like the Roman walls; or they must be shored up against bulging, as with the Gothic buttresses, or they must be tied together, at the springing of the arches, by rods or cross beams, as we see in many of the palaces and halls, in Italy, erected within the last three centuries. The common brick arch of moderate span, however, in all ages, from the time of the Romans downward to the present, has maintained its superiority for many purposes. In the basement story, it is very generally used for cellaring; and, as durability and security in building become more in vogue, we may expect to see its use more extended. Still, the necessary thickness of the walls—the reduced height of the sides within—and the depth of the vaulted ceiling—give a gloom to vaulted apartments, which unfit them for cheerful habitation, and render them inconvenient for general purposes.

A new mode of building incombustible flooring has been getting into use, during the last thirty years, which bids fair to be very generally adopted, where security from fire and durability are objects of value. This consists in placing cast-iron beams across buildings, and springing flat brick arches between them for floors and ceilings. This method of building has been chiefly cultivated among the woollen and cotton manufacturers, in the northern counties; and through their intelligence and economical devices, chiefly, we have arrived at a knowledge of the best modes of applying this principle of construction. The iron beams, from which the arches are projected, have been made to cover a space of twenty-five feet in the clear; but a much greater weight of iron is necessary in this case, than if the span be divided by two lengths of beam, with a support in the middle. The depth of the beam is, also, much greater, and consequently, a greater space is buried between the floor and ceiling below it, if that ceiling be made like the floor, level. A beam fourteen feet in length, ought to be fourteen inches deep in the centre, and ten inches deep at each end.

These mills vary in their dimensions, but the superior sort average about one hundred feet long by fifty wide, and contain four or five floors, each about ten feet high. The external

walls, whether of brick or stone, must be substantial. If of brick, the foundation ought to be three feet thick all round. The first story, two feet seven inches—the second, two feet three inches—the third, one foot ten inches—the fourth, one foot six inches—the fifth, if there be one, may be reduced to one foot two inches. Great care must be taken that the foundation of the main walls, and that of the intermediate iron pillars, may be *thoroughly depended on.* If the natural foundation be decidedly bad—if it consist of sand, clay, mould, or rubbish—it may be necessary to dig a trench under the intended walls of the building, five feet deep, five feet wide at the bottom, and four feet wide at top—to be filled up with well made *concrete;* and similar trenches, filled in the same manner, may be necessary for the lines of iron pillars. But if the foundation be only partially weak, strong bases must be sunk for the pillars. It may be begun with a block or thick slab of stone, free from shakes, not less than two feet six inches square, with squared stones or hard bricks carried up pyramidically thereon, set in the best cement, to the required height, and finished with a plate of cast iron, as a footing for the pillar. The iron beams are placed across, at intervals of about eight feet. Two rows of cast-iron pillars, on cast-iron plates, are fixed along the interior of the building, and the beams are united over these pillars—their extreme ends being fixed on templets in the walls. Iron rods run the length of the building, connected with the heads of the pillars. Thus the iron-work is laid floor above floor. Flat segments of brick on edge, rising an inch in the foot span, are then laid in good mortar or cement. To commence the arch, a row



of bricks, shaped expressly for the purpose, is laid on the ledge of the beam, and when springing from the wall, on the skewback. To obtain greater strength, a second arch is sometimes laid over the first; but this is now seldom done, and it appears to be unnecessary. The spandrils are then filled up with hard rubbish grouted, and, over a level of sand, generally, a floor is laid of bricks, tiles, or stone. In the best arrangements, the staircase is of stone, and carried up on the

outside of the square of the building, with doors to each floor. The engine-house is separated from the mill by a party wall; beyond that is the boiler-house, separated by another party wall; and the furnace is fed outside the building, under a shed. A floor of perforated metal over the boiler, affords an opportunity of using the upper part of that division as a stove drying-house, and there are small iron doors from the boiler-house to the engine-house, and from the engine-house to the mill-house. It has been found that when a fire happens on either floor, it goes no further; but, receiving no aid from the materials of the building, and being approachable with safety, from the external stone stairs, it is generally subdued before it does much damage even there. A fire can hardly originate in the engine-house, but in the boiler-house that risk may be considerable: the party wall and iron door, however, if properly constructed, effectually confine the mischief to that spot.

When the interior of the mill is white-washed, as the window openings are under the ends of the arches, there is little shadow, and the ceiling scarcely strikes the eye to be otherwise than quite flat. The upright walls are free to the level of the ceiling, and are not required to be thicker than in any other strong building.

Formerly, little earthen cylinders or pots were used, instead of bricks, to turn the arches, for the sake of lightness; but these arches, like others, are the stronger for being weighted, and sound bricks are now generally preferred. At Mr. Maudslay's foundry, opposite the Asylum, the great casting-room floor (whereon many tons of iron are moved about), is wholly raised on these arches, projected from iron beams on pillars below. The strength and durability of this mode of building is now placed beyond doubt. It was, also, at one time expected, that as the metal would dilate and contract with heat and cold, those changes would disturb and loosen the joints; but, in practice, it has proved otherwise—the variation is very small and gradual, and, whatever it is, the brick-work is subject to the same influence, and goes with it. In Mr. Maudslay's casting-room, mentioned above, a ton of liquid iron is frequently discharged on the floor, but the work continues visibly sound and unshaken.

Iron Doors, to be effectual, must be hung in iron frames, and these must be bedded in stone jambs and lintels, and, of course, incombustible walls. The strength of the door ought to be proportioned to the strength of the fire which would act on it, in case of accident. Where the whole timber-work of an ordinary built mill, and the machinery and stock in the mill, are on fire within the walls at one time, the fire is so intense, that we have seen an iron door twisted by the heat like a piece of parchment. To meet such a risk, the iron door must be cast very strong, and care must be taken to shield, with a brick arch or the like, any floor which there may be above the lintel of the door, from the action of a fierce flame, which may still issue between the door and its frame. But, in a fire-proof building, no such strong body of fire can arise. A lighter or plate-iron door, will then be sufficient. At the County Fire Office, there is an iron swing-door, in constant motion, which is as light as a door of wood, and yet no doubt can be entertained that it would be as effectual to impede the small fire which alone, in any event, could happen there, as a door of cumbrous weight. It consists of a single plate of iron, an eighth of an inch thick, with styles, munnions, and rails of wood, moulded so as to give it the appearance of a light wood panelled door: the hinges are fixed to the iron plate and frame. As the ceiling of the passage on either side of this door is of stone, and the sides incombustible, if a flame were to penetrate through a crevice from one side to the other, it could not fire any thing. If a door can only be fired on one side, and then only by a slight flame, it may be enough to case over that side of the door with thin sheet iron.

Incombustible Roofs, *covering a large span*, remain yet to be noticed, to render our fire-proof construction complete. As might be expected, the first attempts in making large cast-iron roofs failed in several instances from various causes; but out of these failures, security has been drawn. Perfectly safe cast-iron roofs are now made, not heavier, and very little more expensive, than timber roofs. The castings of the best founders may now be depended on: it is now ascertained where the strength of a beam is chiefly wanted, and where weight may be economized. The joinings are now so effected, that if any one principal be found

defective, it may be taken out and replaced, without disturbing the rest. To enter fully into this subject, would be unnecessary and presumptuous in me, while the scientific works of Treadgold and others, on the subject, are before the public; and to describe the best roofs, at any length, would be unprofitable, now that so many are executed, and open to public inspection. Among the iron roofs, those at Mr. Maudslay's factory, and those erected by Messrs. Bramah, at Windsor Castle and Hungerford Market, deserve particular notice. But we must enter our protest against the admixture of wood and iron beams in the same roof: it not only defeats the fire-proof object, but they do not work well together; they are subject to different laws of dilation and contraction with heat and cold. Iron and brick-work expand nearly alike with heat. Iron roofs are particularly desirable for Picture Galleries, Museums, and Libraries, where no incombustible floor intervenes between the roof and the valuable depôt, and which would be destroyed by the firing of a timber roof.*

* A large iron roof, constructed by Messrs. Bramah, is now fixing over the National Picture Gallery, building at Charing Cross;—it is quite consistent with the skill of the eminent architect employed in this work, to render it fire-proof. But a building constructed on that principle will be valuable for *other* public purposes; and we may yet hope ultimately to see the National Picture Gallery of Great Britain removed from the heart of the most smoky city in the universe. Sea-coal smoke, the enemy of every thing, is particularly destructive to pictures. Independent of its corrosive action on colour and canvass, its sooty coating defaces the finer tints of a picture in a single season, and in a few years entirely conceals them. If any one doubts this, let him look on the pictures in Guildhall, and other halls in the city; they are masses of soot and dirt. Let him notice the paintings in the Council Chamber of the Royal Academy,—they are *chef-d'œuvres* of the artists of our own time; but they are so overlayed with smoke and dirt, as to be turned from with disgust. Let him call to mind the vividness of West's Lazarus, when it was first exhibited, a few years since; or the freshness of Hogarth's pictures, when first hung up at the National Gallery in Pall Mall, and then regard their present obscured condition. It is painfully demonstrated to every artist's eye, that paintings hung up in London, in a few years become lost as objects of admiration. The general effect of a celebrated painting may be discovered through the coating that defaces it, as a swathed mummy may indicate the form of the body within; but the life-touches of the gifted artist—the effects which gave delight and instruction, are buried. This continual picture smoking can only be got rid of by frequent picture cleaning; but it is well known that every scouring, re-canvassing, and touching-up of a fine picture, is fraught with its destruction. Paint, like every thing else, wears away under solvents and attrition; and although it may be said

Fire-proof construction may be extended very beneficially to various purposes, beyond those to which it is at present applied. What immense losses among the cotton warehouses, at Liverpool, might have been spared, had the buildings been fire-proof! The valuable depositories of goldsmiths, jewellers, and glass and china men, ought to be fire-proof: and so ought the

that with a delicate and skilful hand, the abrasion in cleaning is of the most superficial kind, yet the beauty of a fine picture often depends on touches equally superficial. How many of the finest specimens of Venetian colouring have disappeared under the hands of the cleaners. What we now see are, at best, but clever imitations of what the pictures were; generally, it may be said, if pictures are smoked and not cleaned, they become invisible; and if they be cleaned (repeatedly) they are destroyed. Either way they are lost;—the only way to save them is not to smoke them.

The National Picture Gallery, therefore, ought not to be in the midst of the smoke of London, nor even within its reach. The northern extremity of the Regent's Park is the nearest approximation to London smoke, that can safely be trusted. The higher part of Greenwich Park, next Blackheath, would be still more free from smoke; but the centre of Richmond Park would ensure the purest atmosphere.

The opponents to a suburban site for the National Gallery insist, that unless the pictures be near the centre of the metropolis, few will take the trouble to go to them. The same thing was predicted of the Zoological Gardens; and yet, in fact, ten times as many persons travel thither as ever assembled at the Tower or Exeter 'Change. It may safely be inferred, that if the National Picture Gallery were near these Gardens, ten times as many would visit the pictures there, as have seen them in Pall Mall. A walk or short ride out of the murky atmosphere of London, gives a bodily refreshment to the visitor, which adds to the zest of his mental treat; while the purer air of the country shews the subjects to advantage. The public are not insensible to this double pleasure. It is again said, that artists will not spare the time to go far from their painting rooms;—the answer is, major objects must not be sacrificed to minor ones. The first consideration is, the lasting preservation of these gems of art; the second, that their merit may be seen in perfection. Unless these points be well secured, the artists themselves cannot enjoy the benefit of the pictures for any length of time. The permanent interests of artists and the arts must be consulted. The desire of the artists of the day is a minor consideration; but even this, if rightly directed, must lead them to prefer a pure atmosphere to a foul one. In the intensity of their pursuit, they are too apt to forget the care of their health. It is for their good that they should be forced to take exercise and fresh air. Their walks across the park would probably not take up more time, than, for want of exercise, they would lose by the interruptions of health; or, if they would, for a while, pass the greater part of their time at the Gallery, as is done when studying abroad, they can board and lodge as cheap in the villages, as in the heart of the metropolis; and acquire a stock of health, as well as knowledge. The preservation of the pictures—the seeing them in perfection—the essential interests of the arts and artists, all indicate the necessity of placing the National Collection of Pictures out of the smoke of London.

hazardous manufactories of sugar-refiners, distillers, oil-pressers, coach-makers, japanners, tallow-melters, wax-refiners, printers, and the like.

Where the hazard from fire, and the stake involved in such hazard, are both inconsiderable, it may not be worth while to travel out of the beaten path to guard against remote and insignificant risks. But where buildings, or their contents, are of great value, or the operations in or about them, are hazardous, or the inconvenience that would result from their being destroyed would be great, the rendering them secure from fire may be an object of pecuniary economy.

The estimated extra expense of a fire-proof mill over that of a sound building of the common construction, is fifteen per cent. This is computed on the building of bare walls and floors; but if the extra expense be computed on the value of the *whole matter of a superior building exposed to the danger of fire*, including good finishings, good furniture, and probably good pictures and books, the extra expense may not exceed five per cent.

There are few cases where much may not be done to lessen the risk of fire, and none where many of the accidents, as they are called, which continually lead to the destruction of property, may not be guarded against, if common discretion be used. We daily see how effectually a house is secured against the conflagration of an adjoining one, by the legislative precaution of a party wall carried through the roof; and we also see that where iron doors, properly made, set, and closed, are introduced in such party walls, the security is still enjoyed. Why not, then, divide the risks of extensive and valuable edifices into several parts by the same means? There need be no sacrifice of appearance or convenience; and if it should cost a little more to have a few party walls, the additional expense would be but small, compared to the value of the building and its contents exposed to destruction; and would be amply compensated by the safety, the increased strength, and durability of the building: to say nothing of the comfort of feeling secure from fire. We have seen few large mansions or public buildings which might not have been effectually separated into four or five distinct

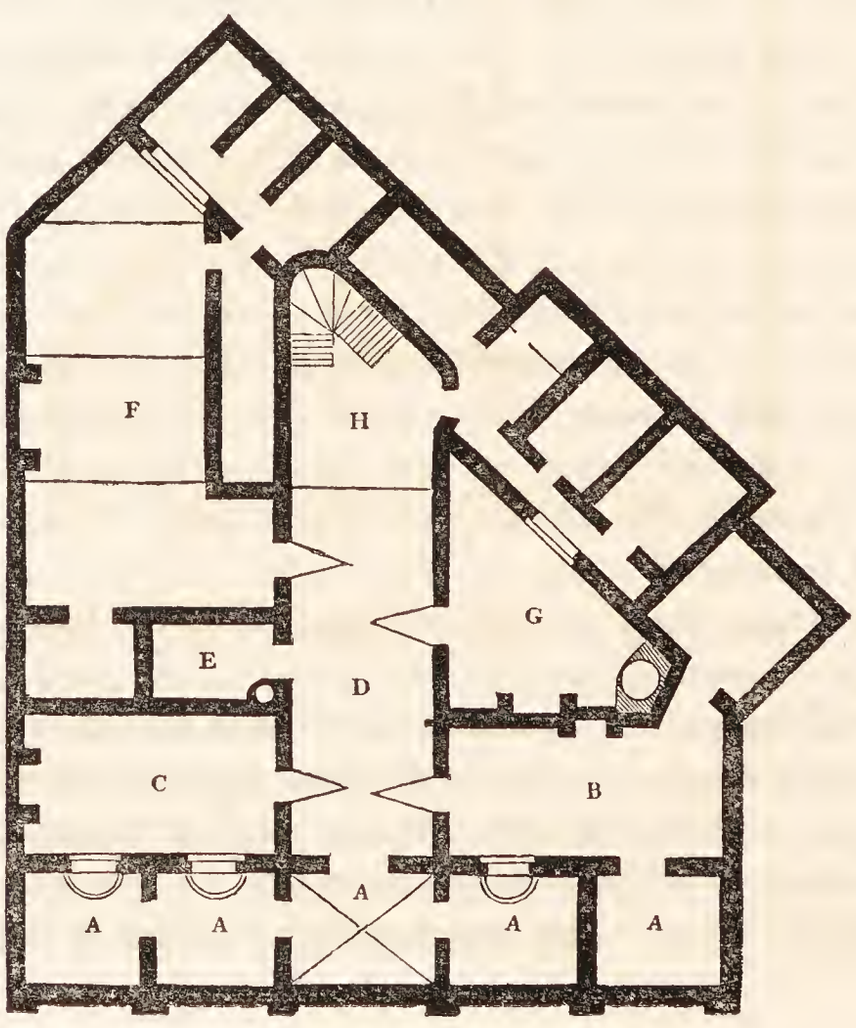
risks by party walls, without inconvenience or material expense. The late destruction of the two Houses of Parliament and various offices, would not have reached the extent it did, had any forethought been exercised in providing against fire; a danger very likely to happen in a range of buildings so extensive, and abounding with large fires, and piles of carpentery, and papers. A few iron doors might have preserved the beautiful interior of St. Stephen's Chapel in as perfect a state as its vaulted chamber beneath still remains in: two party walls carried up at right angles with the south end of Westminster Hall, one on either side of the large window there, and another parallel to it at the entrance to the House of Lords, would have formed an area in front of the window, which would have placed that edifice out of the imminent danger from which it was preserved, almost miraculously. The required entrances to the Houses of Commons, Lords, and Committee rooms, through these walls, might have been secured with iron doors. These would have preserved the House of Commons and its offices to the east, the Committee rooms, &c., to the westward, and have confined the risks of the House of Lords and its offices, to the southward, within themselves. The latter range of buildings would have admitted of several subdivisions of its risks by other party walls; and by hanging iron doors in the apertures cut through substantial ancient walls, which, although mutilated to suit modern wants and fancies, and scathed by the fire, remained erect and firm in their strength, while the modern parts of the building were only to be traced by heaps of loose rubbish. So might the old Custom House have been separated by party walls, into several risks, without inconvenience, and the fire which consumed the whole, have been limited to the part in which it broke out.

But besides party walls, one or another of the incombustible floors just described may be introduced in all good buildings without difficulty. It is something to have the basement story fire-proof, if we go no higher; common brick arches will do for the passages, York landings for the smaller apartments, and iron beams may support flat brick arches for the wide span of the kitchen ceiling. This would confine the risks of the kitchen

within itself, and afford a safe strong room for plate, &c. It would also give the means of warming the house by horizontal flues, under the pavement of the hall, upon the Roman principle, as described in the next chapter; and if the parlours be paved, (and why not, if they are carpeted?) or be only partially paved, a turn of the stove flue may be made to keep them always comfortably warm. But if there be pictures, books, or other articles of great value in the two principal floors, the fire-proof principle may be extended to them. The iron beams and flat brick arches may compose the fire-proof ceilings of the parlour and first floors, and wooden joists and flooring over the fire-proof; and joists and plastering beneath, to give a level ceiling, would conceal the unsightliness, or rather, the unusual appearance, of the flat arches. The triple floor, however, will occupy a depth of two feet at the least.

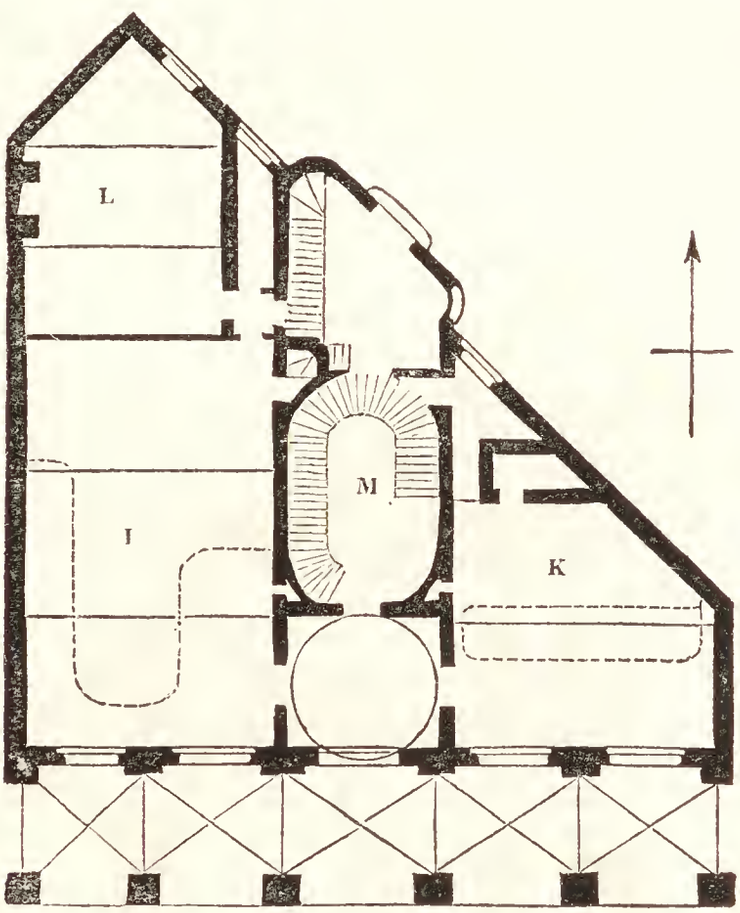
In the County Fire Office all the means of fire-proof and heating, herein recommended, have been applied.

Plan of the Basement of the County Fire Office.



A,A,A,A,A, is a range of wine and other cellars: B, man's room: C, housekeeper's room: D, servants' hall or passage: E, stove-room, with a store-room behind. All these are vaulted over with common brick arches, because the bearings are short and the walls strong; and such arches are the cheapest and best: F, the kitchen; the width here being twenty-two feet, iron beams are carried across at the places marked, and flat brick arches are laid from one to another for a ceiling: G, the wash-house; as the bearing is short and the sides irregular, York landing is used here: H, part of the passage under a York landing, which runs north and south, in part supported by a cast-iron beam.

Plan of the Ground Floor.

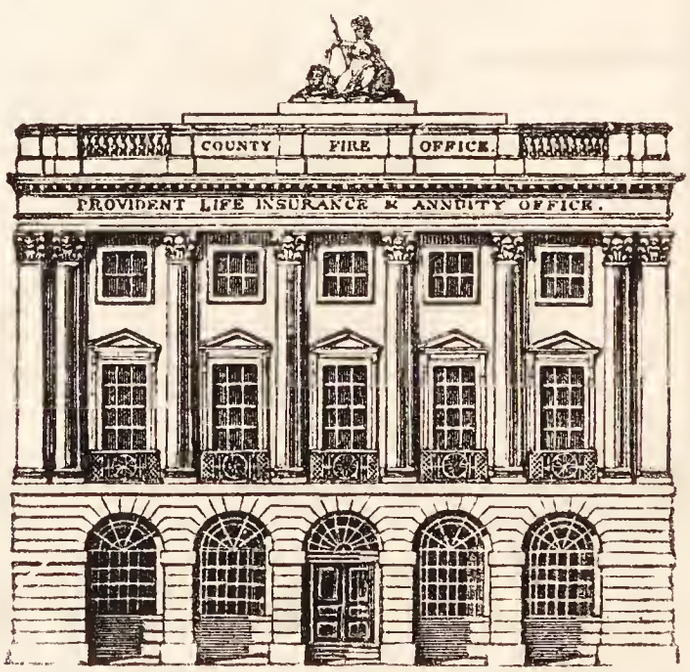


I, the Fire-office, twenty-two feet wide: K, the Life office, and L, the managing director's office; cast-iron beams are placed across these offices, ten feet asunder, at the places marked with lines. Flat brick arches are projected between them for ceilings: M, the principal staircase; the ceiling of this part is

of York landings, supported by cast-iron beams. The curved lines of wall were unfavourable to spring brick arches from.*

By this arrangement the whole of the office floor, where the valuable books, papers, and securities are deposited, is fire-proof; so is the basement beneath, and the principal staircase above. The upper rooms are not fire-proof, but as there are no battened walls in the house, and but few quarter partitions, little apprehension from fire need be entertained for them. If, however, a fire should happen there, the staircases of stone would afford ready and safe access to subdue the fire, or to escape from it.

* As the iron beams of the County Fire Office are twenty-three feet in length, it was thought prudent to suspend an iron rod, of an inch and a quarter diameter, immediately beneath each beam, which rod passing through a loop under the centre of the beam, and being pinned through lips at the two ends of the beam tends to support the beam. Should it incline to bend, or should it crack, the rod would support it, it is presumed, until it could be replaced by another. Since then beams of a greater length have been used without that additional support, but not with uniform safety.



CHAPTER IV.

The means used for heating buildings frequently set them on fire—Great waste of fuel in open fire-places—The Roman method of heating the best—Vitruvius on heating—Description of the Caldaria at Pompeii—Swedish and German stoves—French stoves—Braziers in Italy and Spain—Heating by hot air—by steam—by hot water—Mr. Perkins's patent hot water apparatus—Trials of different methods at the County Fire Office—Satisfactory result—A method described by which the required degree of warmth is obtained free from impurity, dirt or dust, with a twelfth part of the fuel usually consumed—Important discovery for the heating of all churches, chapels, hospitals, gaols, and other large buildings, as well as private dwellings.

As the means used for warming buildings frequently set them on fire, they deserve particular notice in our present inquiry. Considering the awful consequences of these accidents,—considering also the advanced state of science, and its application to the useful arts in this country, and the numerous inventions and expensive apparatuses which have been successively offered to the public, it is really marvellous that so little should have been effected to give the public the comfort of warmth without setting them on fire, or smoke-drying them. No application of fire can be worse adapted to the warming of a building than the open English fire-place. Whatever charms for the eye our blazing coal fires may have, and however useful they generally are in forcing a ventilation, the little they do in heating an apartment, compared with the consumption of fuel, is remarkable. All persons of observation must be sensible that a great part of the heat generated by the fire goes up the chimney, and is wasted.

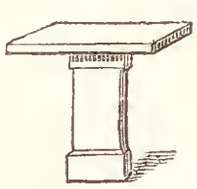
The ingenious and learned author of "The Theory and Practice of Warming and Ventilating Public Buildings," &c. in speaking of the waste of heat in the large chimnies of farm houses, says, "It would not be too much to say, that at least three-fourths of the heat produced from wood fires, is lost to the apartment, by its escape up the chimney:" certainly not,—but it is a great deal too little to say. Dr. Franklin was nearer the mark when he supposed that not more than a fiftieth part of the heat evolved warmed the apartment, the rest escaping up the chimney.

Most persons are aware that fuel, consumed in a close stove or furnace, and applied to the production of steam or hot air for heating rooms, is more effectual than when consumed in common fire-places; but few are prepared for *the fact*, which we are now enabled *to demonstrate*, that even in enclosed stoves, or furnaces for hot air or steam, only *one part in twelve of the fuel* consumed fulfils its destination of heating the building; while the mass, the eleven parts in twelve, rushes up the chimney, and is wasted in the open air! This will be presently shown: in the mean time, pursuing an inquiry into the different modes of *heating* buildings, somewhat chronologically, as has been done, in speaking of fire-proof *building*, it is curious to remark, that the best methods of construction for both purposes, are still visible in the works of the ancient Romans.

In looking over the baths of Pompeii, for example, we find that the *Caldarium*, a hot air chamber, was heated in the following manner:—The whole of the floor, consisting of stone flags, three or four inches thick, is raised upon brick piers, nine inches square and about nineteen inches high, leaving a vacancy of that depth beneath the floor; the surface of the floor is stuccoed over to the thickness of about an inch; round the walls of the room there is a casing of tiles set on edge, and securely fixed with iron ties to the wall, but so as to leave an interval of a few inches between them and the wall, and these tiles are also stuccoed over; then the flues from two boilers, which have been placed on the outside of this apartment, opens beneath the floor, and the draught of heat diffusing itself there ascends between the wall and casing on the opposite side, and finds an exit at the top. This principle of heating the hot room of their baths, under

various modifications, appears to have been universal among the Romans, and nothing could be better adapted for the purpose. The bathers being accustomed to walk, sit, and converse, naked and bare-foot, in these rooms, it was necessary that the heat should rise through the body of the floor itself,—and this it did copiously and with purity; and as this draught of heat was only a continuance of the furnace and flue, after they had done their work in heating the boilers, it was an economical application of the surplus heat, which, had there been only a common chimney to the furnace, would have passed off in waste.

A detailed account of the construction of these Roman hot houses is given in the works of Vitruvius. These heated rooms, on a smaller scale, appear to have been provided in every Roman villa. They have been discovered in England, wherever the remains of Roman habitations have been found. At Wroxeter in Shropshire, there is a small Caldarium, about twelve feet square;—the pavement is carried on brick piers, between eight and nine inches square: each pier is raised on a tile, a foot square, and is surmounted by another tile, two feet square; over these is laid a thick coat of broken tiles, coarse gravel, and lime; and this is finished over with a fine stucco. Round the pavement against the wall there is a range of hollow bricks, to communicate the heat from the Hypocaustum, to within a lining of the walls above, apparently as at Pompeii. There are two of these Caldaria to be seen at Chester,—one near the Plume of Feathers Inn, the writer saw some years since. "The Hypocaust, which



is of a rectangular form, is supported by thirty-two pillars of moulded pottery, each one foot ten inches and a half high, and about eighteen inches distance from each other; upon each pillar is a tile eighteen inches square, and over these a pavement is laid of other tiles, two feet square; the whole is covered with a thick coating of cement." In the year 1770, a similar heating apparatus was discovered in the ruins of a Roman villa, near the Infirmary at Chester.—Similar Roman Hypocaust and Sudatory are still visible at Leicester; and at Sir W. Hicks's, near Cheltenham; they have also been dis-

covered in various other places in England, but have not been preserved.

In China, a method of warming their apartments, similar to that of the Romans, is in use at the present time. Father Gramont (Phil. Transactions, 1771) gives an account of their method:—The pavement of stone is laid hollow, and is coated over with stucco; a flue crosses the middle of the area, and is crossed in the middle by another, at right angles with the first; holes are made in the sides of these flues for the heat and smoke to pass through, and diffuse itself over the whole of the area, from which it is carried off by upright shafts at the sides. This does not seem a very good application of the principle. It is difficult to conceive how the draught can traverse both limbs of the cross flues, and to imagine how they can be got at to be cleaned: still it seems that they are very effective, and universally in use among the better sort of houses in and about Pekin, where the climate, in winter, is as cold as at Petersburgh.

In Russia, Sweden, Germany, and the Low Countries, they have two sorts of stoves in use for heating buildings;—the one is a square mass of furnace and flue, made of brick, which projects into the apartment intended to be heated, to about the size of a double chest of drawers: the door of the furnace opens in the passage: here the fire is fed with logs of wood; and as the flue makes two or three turns backward and forward, before it ascends in an upright shaft above the roof of the house, a considerable part of the heat is given out gradually and inoffensively. It also retains the heat a long time, and continues to diffuse it in the apartment and passages, after the fire has gone out. The other is the well-known German stove of iron, with iron pipes, made of all sizes and prices, from simple lapings of a few plates of iron, to ornamented cast-iron stoves of great magnitude. These iron stoves and pipes are much more effective for heating an apartment than those of brick, because heat is much more freely transmitted through metal than through earth; but the offensive, oppressive, and unwholesome smell, which always proceeds from large surfaces of iron, at a high temperature, and the occasional effusions of smoke, and the danger of their

firing the house, are serious objections against the domestic use of iron pipe stoves. In France, besides their large open fire-places for wood fires, they warm their rooms with stoves placed some feet within their rooms, which stoves are embedded in circular brick-work of glazed and ornamented porcelain, bound round with hoops, and having a metal pipe to communicate with the chimney flue. In France, also, as with us, the iron stoves and pipes are pretty much in use. In Italy and Spain, as in the classic ages, they still continue to warm their apartments with fires of charcoal, or wood embers, placed in large metal pans in the middle of them. This application of heat, however objectionable it may be on the score of health, is certainly the one which makes the most of the fuel used, for the purpose of obtaining heat; because the *whole* of the caloric disengaged in the combustion of the fuel is diffused in the apartment intended to be heated.

During the last thirty years, we have been interested with a succession of inventions for the conveyance of heat from furnaces to apartments desired to be heated. Air, steam, and water, have been the media of transmission.

Hot-air Stoves are generally of two kinds: 1st. They are furnaces within a dome or case of cast-iron, called a cockle, with iron pipes to convey the smoke away. By Mr. Perkins's plan the cockle is set in an air chamber, and the smoke-pipe is enclosed in a much larger pipe. A volume of cold air is then admitted into the air chamber from underneath, which is heated by the cockle; it then rushes onward between the smoke-pipe and the outer pipe, deriving its chief heat from the smoke-pipe, and finally passes through lateral apertures in the outer pipe to the different apartments required to be warmed. 2d. Another sort of hot-air stove consists in a very large covering of *plate*-iron to the furnace, generally about a yard square, and five feet in height. In this the flame of the furnace reverberates, and makes its exit at the back, into a flue usually of brick. This cockle is placed in an air chamber; the cold air is made to strike on the lower half of the cockle, through some hundreds of short pipes which open within an inch of the plate; by that means heated, it has to traverse over the upper part of the cockle, and get away

as it can, through a similar system of pipes, which afford egress for the heated air to the air flues which convey it to the apartments desired to be heated. In this sort of stove the air is heated by its contact with the cockle only; it draws no heat from the smoke-pipe: instead of the short iron pipes, above described, the cockle is sometimes surrounded by bricks placed so as to leave alternate holes for the passage of the air. This stove was in some repute about fifteen years ago, particularly in the cotton and woollen mills, and public hospitals, in the neighbourhoods of Derby and Leeds. They were introduced into London by a Mr. Silvester, from Derby, but it is little used at present. Both of these stoves are dangerous, and have caused serious losses: the cast-iron cockles are apt to crack; the flame then rushes with the hot air through the hot-air flue, to a surprising distance, and fires any combustibles within its reach. The sheet-iron large cockles are apt to warp with the heat, and cause fissures at the joinings, through which the flame escapes, in the same manner and with the same effect as with the cast-iron cockles. Nevertheless, for the heating of the stove-rooms of various manufactories requiring a high degree of heat, and where the contamination of the air by the hot iron is not regarded, the cast-iron cockle and pipe may be advantageously used. The smoke-pipe ought to be of a large size, and of cast-iron; it should extend or revolve a sufficient length in the place to be heated, to allow of the transmission through the pipe of nearly all the caloric that enters into it from the furnace, before it enters the upright chimney shaft. By these means nearly all the caloric disengaged by the combustion of the fuel will be economically collected in the place to be heated, and with judicious precautions, but not without, it may be used with little danger.

Nott's patent stove (69, Fleet Street), an ingeniously contrived *close-stove* of cast-iron. It affords a glimpse of the fire through pieces of talc: after it has been lit it is fed by the dropping of coal from a hopper over the fire-place, which hopper does not require replenishing oftener than once in six or eight hours. As the draught of air admitted is very small indeed, the combustion is slow, the coals rather mouldering than burning; the smoke is in some degree consumed. If a

large draught of air be admitted, the fire burns fiercely, as in other close stoves or furnaces, but then the heat is corrupted with the odour of burnt air. In either case an apparatus for ventilation is necessary, and this is the more required, as some effluvia must come off from the heated coals in the hopper. An ordinary sized stove of this kind costs about twelve pounds.*

Heating by Steam-pipes, is free from danger if the furnace and flue are free from timber. It is applied to manufactories

* Without entering into a disquisition of the merits of the numerous projects for curing smoky chimnies, which are continually advancing and receding to and from public notice, we may be allowed to offer a few practical hints upon that subject. If not from an obstruction in the chimney itself, the smoking arises from a current of air down the flue. This is occasioned by eddies in the air above the chimney top, in consequence of some resistance to the free passage of the air over it, or from a warmer temperature in the apartment below, than that of the air above, causing a draught down the flue. Whichever be the cause, the cure may in general be effected by the same means, viz. that of raising a sufficient upward draught to overcome the downward tendency. This, in the case of an open fire, may be generally accomplished by contracting the opening of the fire-place to the width of the fire, and reducing the height of the opening over the fire to about fifteen inches above the bars. It is even necessary to close this last opening in some desperate cases, by hanging a blower on, whereby the fire-grate is brought nearly to the character of a close stove. A large and wide opening between the fire and the flue is a well known cause of a room smoking; Rumfordizing the hobs is a partial amendment. A Register stove goes further, by more effectually narrowing the opening for the passage of the smoke; but this is incomplete, because it leaves an air chamber above the register, which is much larger than the flue.

An excellent sort of open fire-grate is in use at the County Fire Office, which subdues an inveterate smoky chimney. The back and sides of the fire-grate are composed of Welch lumps, the fire-grate eighteen inches wide by eight deep, is but little larger than the flue, and *from the sides of the grate, the brick-work is carried straight up to the flue*, so that from the burning coals to the chimney top, the draught is confined to one uniform column, but which is strongest in the lower part. A downward pressure, therefore, cannot bend the draught from its direct ascent, as it might do if there were a wide space over the fire-place. The bottom of the grate is about nine inches from the hearth, there are only two bars in front above the grating; these are segments, and there is a second grating even with the lower bar, so that, in effect, there is but one bar above the bottom of the fire. From the grate to the chimney-piece jambs or pilasters within it, there are plates of cast-iron ground, and a third plate over the opening, which are splayed off at an angle, which varies according to the size of the chimney. By this arrangement there is very little depth of fuel, and consequently, very little smoke made; and the radiant heat placed low is well reflected into the room from the sides and upper splay. It is in every respect the neatest and best open grate we have seen. It is made by Mr. Feetham, Clifford Street, Mr. Bevan, in Marylebone Street, and many other manufacturers and the price, unornamented, is about £10.

and hot-houses, with success. But the apparatus, if well constructed, is very expensive; and if of inferior workmanship, it becomes equally expensive, from the necessity of frequent repairs; indeed, at the best, repairs are more often required than is agreeable, and the consumption of fuel is great. The steam-pipes are a great eye-sore in buildings and apartments where appearance is regarded, and the attempts to conceal them often make bad worse; placing them between the joists under the floors, besides disturbing the construction of the house, injuriously lays the ground work of frequent after disturbances, for the repairing of leakages at the joints, which from time to time happen. If the pipes are placed over the floor they are in the way, and ugly; if raised toward the ceiling they are frightful. The best plan is, to conduct and revolve them in the opening of the fire-place, having bricked up the flue over it, but this space is insufficient to afford sufficient heat for a large apartment.

Heating by flat steam-pipes, or rather, through the iron-plate casing of a sheet of steam, gets rid of the unsightliness of steam-pipes, and offering a much larger surface from a given area than a circular pipe, it gives out a greater quantity of heat. This flat pipe (as called) consists of two sheets of iron, about two feet wide and half an inch apart, made into a case for the conveyance of steam, and set up on edge about an inch from the wall, forming a sort of skirting. But this contrivance is more expensive than common pipes, and more frequently needs repair, for the dilation and contraction of the sheets of iron are rapid, and the long joints in one place or another, often give way. The power and the sightliness of this application of steam, and also the oozing at the joints, are visible in the conservatory at the Colosseum, Regent's Park.

Heating by Hot Water, has lately become a favourite mode, and is now pretty generally superseding the use of steam in dwelling-houses. The apparatus consists in having a boiler at the bottom of the house, and a cistern in a higher part of the house, and connecting the two by two pipes, one from the lower part of the boiler, the other from its upper part, and both opening into the cistern at the top of the house; the whole forming, as it were, one vessel. Then, as the heated water will rush to the surface as fast as the heat from the furnace inpinges

on the boiler, that portion of the water rushes through the upper pipe to the cistern, and its room is filled up by colder water, which descends from the cistern through the lower pipe into the boiler. In this way a rapid circulation takes place, and the whole of the water is soon heated. This mode of heating was brought into notice, about fifteen years ago, by the Marquis of Chabanes, but he was not successful in applying it. It is now made highly convenient, not only for warming apartments, but for supplying any quantity of warm water in any part of a building. Messrs. Bramahs, among numerous buildings, have fitted up St. George's Hospital with a warm water apparatus of this kind, by which, part of that building is not only warmed, but as the cistern contains eight hundred gallons of warm water, an abundance of it is at all times ready for the bathing of patients. The heat conveyed by these means at the hospital seldom exceeds a hundred and twenty degrees. In other places where the quantity of water is less, and the boiler more acted on by the fire, it rises to two hundred degrees: but steam will convey heat up to three hundred degrees; therefore, to obtain the transmission of a certain quantity of heat by hot water, the pipes must be larger than the steam-pipes. This is an inconvenience; but, on the other hand, as these pipes are never dilated by the extreme heat which steam-pipes have to sustain, and being always full of heated water, are never contracted by cold as they are, they remain sound when steam-pipes become disjointed. This consideration, in addition to that of yielding warm water in abundance in all parts of a building, give this mode of heating the preference it is now acquiring.

The Orangery at Windsor Castle, is heated by a warm-water apparatus, constructed by Messrs. Bramahs. This is a most satisfactory application, the heat being kept up to the required degree throughout the night without any attention to the fire. The apparatus and the supplying of it with fuel must be expensive; but the warm water contrivance may be very economically applied to the warming of a dressing room on the ground floor, and also to the giving a warm water bath (always ready) by a communication from a boiler in the back of the kitchen range. The boiler should be of wrought, not cast-iron.

The *patent Hot-water apparatus of Mr. Perkins*, for heating buildings, is a modification of that ingenious gentleman's contrivance for heating water red-hot. He has a convolution of pipes which are placed in the furnace, and other convolutions which are placed in the apartments intended to be heated; and these convolutions are connected together by two pipes, for a descending and ascending current, as in the preceding case. The whole is completely filled with water, and hermetically sealed. A heat may then be applied to the pipes with safety, that would burst them if filled with steam. But this safety depends on their being *entirely* filled with water. If a little of the water were to escape, the pipes would burst. But it is insisted that no water can escape, and we have heard of no accident. An intense heat being conveyed by water thus heated, and confined, may exceed three hundred degrees; the pipes, therefore, are not required to be so large as steam-pipes, nor nearly so large as hot-water pipes, to diffuse a required degree of heat. This is a material convenience in the fitting-up of apartments. Mr. Bevan, stove-grate maker, in Marylebone Street, St. James's, is agent for Mr. Perkins, in the making of these stoves; his shop is warmed by this apparatus, from a furnace in the basement; the whole expense of which, he says, is about thirty pounds.

In all these modern applications of heat, there are two great defects. The first is most obvious in the heating of churches, chapels, and all large chambers, having stone floors. However large the fires may be, and the volume of heat they deliver, there will always be an ingress of cold air (in cold weather), and this will form a stratum over the pavement of the building. The strongest heat will rise to the highest space above—the air, which is the least warmed, will remain in the lower portion of the building—and the *last cold air that steals in will rush along the pavement, and always keep that part cold.* Hence, although a man feel warmth to his face, his feet will suffer from the coldness of the pavement. In short, that part of his body will be dangerously chilled, where warmth is most important. The second defect is, *the great waste of fuel in proportion to the heat gained*—at the least eleven parts in twelve of the heat generated passing in waste, up the chimney.

A history of the warming of the County Fire Office, will illustrate these facts in a striking manner. About fifteen years since, Mr. Silvester's hot air apparatus, which has been already briefly described, was introduced into the building. After a short time, owing to defects in the cockle, flame mixed with the hot air, and set fire to a quantity of shavings and chips, left by the carpenters, in the hot air chamber above the cockle, which extending through the flues, would have fired the house, had it not been constructed fire-proof. Subsequently, so much smoke mixed with the hot air, through chinks in the joints of the cockle, that after two years' endurance and tinkering, this apparatus was removed. Another inventor then had leave to try his steam apparatus; but, after a similar probation, the inconvenience occasioned from defects in the work, and from the condensation of the surplus steam in the flue, and the great consumption of coal, determined the directors to have that also removed. The hot air stove and the steam apparatus, each raised the required degree of warmth in the office, but subject to many annoyances, and a great consumption of fuel. A mode of heating was then contrived, which has been followed by the most complete success, and which is invaluable for warming all buildings having incombustible floors.

It was remarked, that under the hot air and steam heating systems, although the air in the office was sometimes too hot, still the clerks always complained of cold feet. They had mats given them to stand on, and they frequently left their desks to get a warm at the hot air vents or the steam-case; but still their feet were cold. It was considered that this could only be overcome by causing the heat to arise through the paved floor itself. The mode of heating the Caldaria of the Roman baths proved the practicability of that mode of heating. This was further corroborated by the evident warmth of the pavement in the streets, over bakers' ovens. A flue was accordingly constructed under the paving of the office, the paving stones themselves forming the roof of it. The area of the flue is a foot square: it begins on one side of the office, travels under the pavement along that side, across the top and down the other side, where it enters an upright flue in the party wall. The course it takes

is shewn in the dotted line in the plan, in page 39. In this course, it passes under the feet of the clerks, which it keeps comfortably warm; the heat being filtered, as it were, through stone, and being uncontaminated by heated metal, it arises in the utmost purity. There is no longer a difficulty in keeping up the heat to a required pitch; the warmth is so considerable from a mere handful of fire, that the difficulty has been to keep it low enough without putting the fire out. The fire office and principal staircase are kept comfortably warm, during the winter, at an expense of less than thirty shillings a year, or about three pence a day for the cold season. A similar degree of heat from the hot air, and afterwards from the steam apparatus, cost us eighteen pounds annually. This new mode, giving an equal degree of heat, requires only a twelfth part of the fuel consumed by the common furnaces. Persons coming in from the open air, have complained of our keeping such large fires. When they have been shewn that the only fire we had, was a little fire which was burning without fierceness, and might be contained in the crown of a hat, they have denied their belief of the fact, and insisted that the warmth which they felt must have been procured from some other supply. It really does appear like magic; but the case proves this important fact to a demonstration, viz. that only one part in twelve of the heat evolved from the fuel, consumed with the hot air apparatus, and, afterwards with the steam-boiler, went to the heating of the place intended; while the great remainder, the eleven parts of the twelve, went with the draught up the chimney, and was wasted above the house-top.

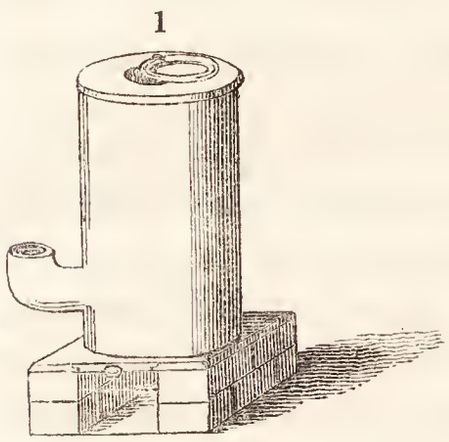
As this method of heating buildings, is equally excelling in the purity of the heated air,—in the beneficial way in which it is delivered (through the floor)—in safety from fire—in preservation from smoke, dust, and dirt—and in economy of fuel—it cannot fail to be generally used wherever it can be applied. It may, therefore, be excusable to be somewhat more ample than heretofore, upon the *rationale* of this system, and on the means used to carry it into effect.

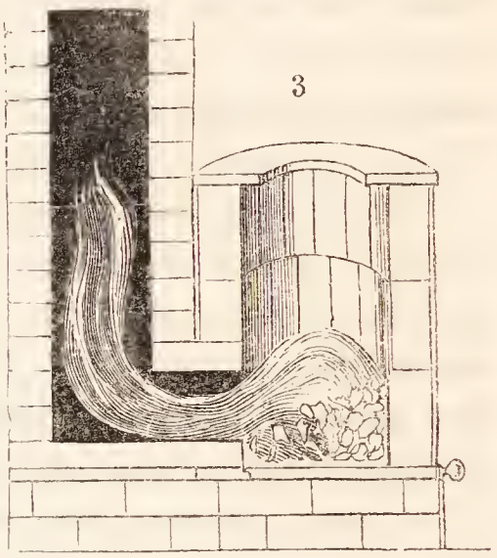
To make the most of fuel used, the first thing is to reduce it to a complete combustion, so that no part shall be sent uselessly up

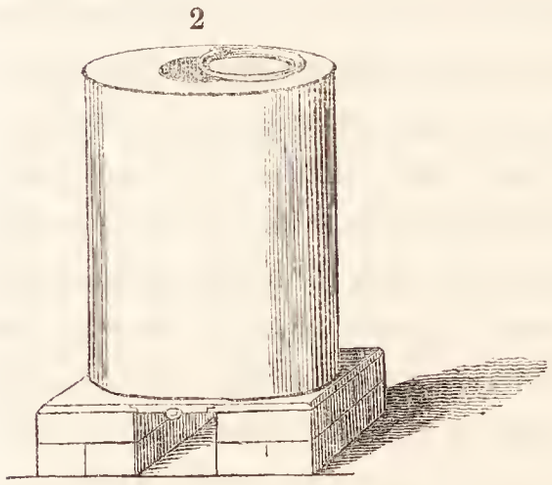
the chimney, as unlit gas and tarry vapour, nor be thrown into the ash-hole, in a half consumed state; but, that all of it that is combustible shall be burnt and evolved in caloric. *The second thing is to confine the delivery of this caloric to the place required to be heated.* Art can do no more—no ingenuity *can add* to the *caloric contained in the fuel.* All that art can do, is to prevent its being wasted; and here much may be done.

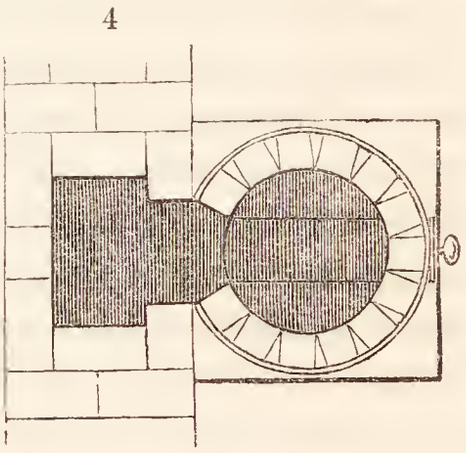
The stove used by the County Fire Office, is a hollow cylinder of cast-iron, one foot in diameter, and two feet deep inside; the shape is something like that of a tall milk-pail (see figure 1); about three inches from the bottom there is an oval aperture, five inches wide by four inches high, from which the smoke-flue proceeds, with a bend like the spout of a tea-kettle, into an upright shaft, which shortly bends under the floor to be heated.—There is a plate over the top of this cylinder which has a circular aperture in it, of seven and a half inches diameter, and a lid.—The cylinder is close at bottom: when a fire is desired to be lit, half a shovel full of coals is first thrown in—then some sticks and paper, or shavings, are put over it, and lit; and some cinders or coke, with a few small bits of coal, are immediately put on the wood, taking care to give the fuel a slope, in such manner, as to leave the opening for the smoke-flue pretty clear; the aperture at top is then *nearly closed.* The first effect, after the fire is lit, is for the smoke and heat to ascend toward the aperture above; but this is opposed by a downward current to the vacuum caused by the fire. The smoke is seen curling about in its endeavour to ascend; but by the time it reaches the projecting lid, it is effectually driven back and carried down by the downward current. This downward current soon becomes strong, and as it makes its way through the side into the smoke-flue, it is there compressed, and acts strongly on the fire, which is there brightest. Then, as it carries with it all the gas and tar which are distilled in the combustion of the fuel, that gas and tar (smoke) becomes *consumed*, and adds to the volume of caloric evolved. The stove used at the County Fire Office, as already mentioned, is of cast-iron; but a better stove may be constructed, on the same principle, of Stourbridge bricks. Fig. 1 represents the cast-iron stove

in use. Fig. 2, 3, and 4 represent a similar stove lined with bricks,—the outside is a drum of sheet iron, one sixteenth of an inch thick, twenty-seven inches deep, and twenty-four and a half









inches diameter within. A foundation of bricks is laid, two courses high and twenty-five inches square, leaving an ash-hole, seven inches wide, as shewn in Fig. 2. Upon this, two plates of cast-iron are laid, each nine inches wide, twenty-five inches long, and an inch thick, with a rabbet, half an inch wide, in their inner and upper edge: these rabbets are to receive a counter rabbet in a middle plate of iron of the same thickness, seven and three quarter inches wide, and twenty inches long,—which middle plate is to draw out, when it is desired to empty the ashes into the ash-hole. A ring is fixed in the front of this middle plate for that purpose. An aperture is left in the drum, twelve inches square, for the smoke-vent. The drum being placed on

the plates, the smoke-vent is then reduced to six inches wide by four and a half inches in height, on the inside of the stove, by a collar formed of Stourbridge bricks or Welch lumps, twelve inches by nine, and three inches thick, set in Stourbridge clay ; and the rest of the inside is lined with three courses of Stourbridge bricks, set on end and on edge, bedded in Stourbridge clay. The drum is then covered with a circular plate of cast-iron, having a downward lip round the edge to receive the upper edge of the drum. In the middle of the top there is a hole, seven inches in diameter, for the admission of fuel ; and this is covered by a lid which moves on a pivot, to regulate the admission of air. It is seldom necessary to leave it open so much as an inch for that purpose. The lid itself is cast with a projecting rim of about an inch, that it may contain a little water ; for a moderate evaporation of water is always an improvement to the salubrity of the air. The management of a stove of this kind is neither difficult nor troublesome in the hands of any intelligent servant. It is only necessary to take care that the smoke-vent be cleared to the back ; that the slide be pushed home before the fire is lit ; that it be well lit before much fuel be put on ; and that the smoke-vent be never choked up, by overloading it with fuel. A small scraper, something like a chimney sweeper's, will be necessary to clear out the vent ;—with its handle it ought not to exceed fifteen inches in length, else a violent servant may injure the brick-work. Six to eight pounds will be the expense of a stove of this description ; and making the horizontal flues under the hall of a first-rate house, will cost about the same sum. When a man is used to it, the fire is kept up with less attention than a common fire. At the end of the day, the aperture is closed and the fire goes out, and all the fuel consumed is found to have left a red ash only, with the half-burnt coke that was in use when the fire was extinguished. In this way we gain our first point, a complete combustion of the fuel in all its parts. There is no discharge of tar and gas to line the inside of the flues with soot, and infect the air with smoke ; nor of unconsumed coals and cinders to fill up the dust-hole ;—all is consumed and reduced to caloric.

A perfect combustion having extracted the whole of the caloric from the fuel, the next point is to secure the delivery of this

caloric in the apartment desired to be heated, and *there only.* This is done by extending the smoke-flue beneath the floor of the apartment to be heated, for such a length, as shall deliver all the heat from the draught, save and except just enough to carry the draught up the chimney. In these ways all the caloric producible from the fuel is distributed only in the place desired to be heated, and a required degree of warmth of the purest kind is enjoyed.*

The experiment at the County Fire Office having been the first of its kind in modern times, was worked hastily, and with less soundness than would have been used in the regular way of business: the flue, which ought to be of an area of at least a foot square, and the same all the way through, having to pass over the crowns of arches, between which and the pavement there was only an interval of six inches, became contracted in those parts; the pavement had only slips of slate under the joints of the stones (cast-iron plates are to be preferred), and the embedding of the pavement in the mortar was by no means perfect. The means of cleaning the flue are also defective; still the thing has

* It is only on the principle of the downward feeding draught, that a fire can be forced to *consume its own smoke.* If the draught arises in the usual way, through bars underneath the fire, whenever a fresh supply of coals is thrown on it, there will be an immediate distillation of the coals: volumes of dense smoke then arise, wasting the gas, tar, and sulphur of the fuel, and poisoning and blackening every thing alive and dead, within its reach. This noxious distillation goes on until the fire has burnt through the molten mass; or a draught of air is procured through it by poking and stirring: the gas and tar then take fire, and add to the quantum of heat. But if the *bottom* of the stove *be solid,* and the *feeding draught be only from above,* and the fresh coal be thrown on nearer the opening than where the most active fire is—the rising smoke will be driven with the draught through that active fire, and be there lit and consumed. Certain trials are now in progress for heating large boilers on this principle; and if the contrivance be found economical and convenient, as well as effectual,—no excuse will remain for infecting the air of the metropolis with the baneful clouds of smoke which now issue from the breweries, distilleries, bakeries, and other places where furnaces are in use. It is expected that no more smoke will escape from the chimney of a steam boiler heated on this principle, than is usually seen from the chimney of a common open fire.

In regard to open fires, it may be pardonable to notice a prevailing vulgar error, viz.—that there is economy in heaping on a large quantity of coals at one time, and letting it cake for an hour or so, before it burns through There may be some economy in the trouble of putting on coals, by thus overloading them—but there is a great loss of heat, the inflammable parts of the coals being sent off in smoke and soot,—which would inflame in light and heat, if the coals were put on in small quantities.

answered extremely well, which shews that nicety of workmanship is not essential to its success: its aperture was made at the junction of the horizontal flue with the upright shaft or chimney, where some lighted paper or shavings might be inserted to force a draught, should it become necessary; but after the flue was once dried, the draught was always effectual without forcing; nor has there ever been any impediment at the narrowed parts of the flue. At the end of five years the flue was swept, for the first time, and only about two pecks of soot, or rather dust, had accumulated.

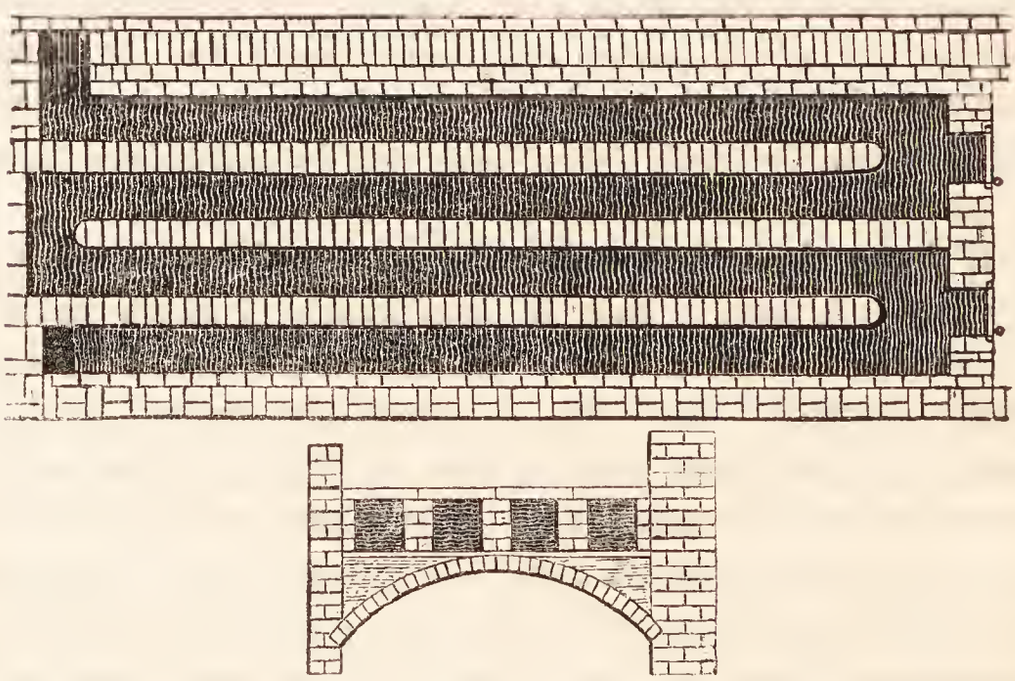
Since then, the Provident Life Office has been warmed by similar means, and with equal success; but there the heat is got from the furnace of a copper, the flue of which, by a contrivance, is, when wanted, turned into the flue under the office pavement. This office is warmed without *any* expense of fuel, as the cinders and ashes from the open fires are alone used in the furnace of the copper.

This method of heating will not, however, as our houses are now built, admit of general application. It can only be used where the floor and the ceiling beneath are of incombustible materials. For all churches, chapels, hospitals, workhouses, gaols, and other buildings where there are vaulted basements and stone floors, this mode is invaluable. It is indeed the only principle on which places with stone floors can be properly warmed. In all private dwellings where there is a vaulted ceiling under the hall, these flues may be introduced beneath the paving with the best effect.

If it be desired to make a house comfortably warm, the only way is to have a body of heat issuing from the pavement of the hall; from that all the passages and stairs above will be readily supplied; and when a room door opens, instead of having to shrink from a cutting rush of cold air, there will be a new accession of warmed air. Every one must be sensible of the severe colds which are caught by persons, who, while heated by a large fire or crowded room, have a cold draught of air thrown upon them from the opening of the door; or who have to leave a hot room, and walk up or down a staircase, where the air is as cold as in the streets, and more piercing from the draught.

The common fire-places and stoves, with descending flues, in halls, do nothing. The men are seen roasting before them on one side, while they are frozen by cold draughts on the other. Except the little radiant heat that partially scorches them, the bulk of the heat goes up the chimney and is wasted; but how different would be the effect, if one-twelfth of the fuel so wasted were applied to a fire, the current from which were circulated through an *hypocostum*, under the whole of the pavement of the hall, in the manner of the Roman Caldaria, or of the County Fire Office! A genial warmth would be equally diffused, from which every inhabitant of the house would derive benefit.

In all good houses hereafter to be erected, this comfort may be secured almost without expense: for example, let the portion of basement immediately under the hall be vaulted, a half brick arch will be sufficient, if the work be good; it may spring from the brick walls in the usual way, or be a succession of flat arches from short cast-iron girders, as found most convenient. If the hall be seven or eight feet wide, there may be four lines of flues occupying the whole length; the flues being twelve or fourteen inches wide, and the same in depth; and there being a nine-inch wall between them.

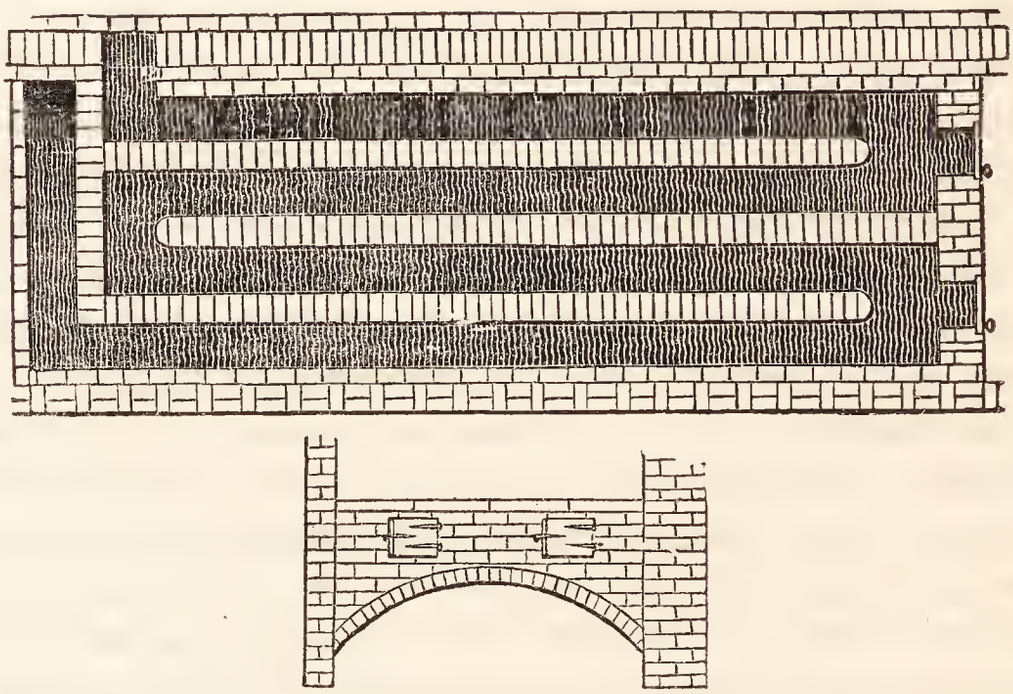


On these walls the courses of paving stone would be laid in mortar, and under the cross joints there ought to be slates, or thin plates of cast-iron, eight or nine inches wide, on which also

the joints should be carefully bedded in mortar. In the vaulted passage or apartment beneath, the cylindrical stove is to be placed; it may be made of cast-iron or Stourbridge brick. The connexion between the stove and the horizontal flues, and the exit from the horizontal flue to the upright shaft or chimney, will not require a description, but it must be especially noticed that if the building be large, and a strong fire be used, that the first eight or ten feet of the horizontal flue ought to have a layer of fire-stone or of fire-brick, or tile-work, beneath the paving stones, or they will be liable to be cracked by the heat. At the end of the arch, under the hall, where the well for the staircase begins, there must be two soot doors.

But when the purity, cleanliness, and economy, of this mode of heating buildings become generally known, there can be no doubt that many persons, in houses now built, will go to the expense of having a hall or passage expressly vaulted beneath, to enjoy the advantage. Where there is already (as there is in many of the better class of houses), a passage from the kitchen stairs at the back to the front area, with a brick wall running parallel to a party wall; and in which party wall there are flues, the work may be very easy. It may only be necessary to cut away all the wood-work between such two walls, and fill up the interval with a brick arch. If there be not two parallel walls beneath, and the hall or passage be on wood joists, over part of a large kitchen or place that must remain open, the foundation for horizontal flues can only be got at by some such means as the following. On the ceiling beneath, mark out the space required for the flues: raise a cast-iron bearer, about eighteen inches deep, on the opposite side of the space to the wall in which the chimney is: support the beam at one end, on the front wall, and on the other by a cast-iron pillar; or if the compartment to be vaulted be long, it may be necessary to have the bearer in two or three lengths, with one or two intermediate pillars. The head of each pillar must be connected with the party wall by an iron rod. Then wedge up securely under the joists, and cut away the space. A skewback must be then cut in the party wall, and a flat arch must be turned therefrom to the iron bearer; and on this flat arch the flue is to be carried.

But as the stove below, in this case, must be against the wall in which the chimney is, the horizontal flue must be carried somewhat differently as in the Figure.



In every case, there must be fourteen inches of brick-work between the inside of flues and adjacent wood-work. Great care should be taken that the outer square of brick-work be sound, and solid with mortar, and that the resting-places of the pavement above are completely bedded in mortar; because, as the draught of the horizontal smoke-flue may be but feeble, if there be any crevice in the flue, communicating with an apartment in which there is a good fire, some of the coke smoke will be drawn into the apartment.

The length to which the horizontal flue may be carried, before it takes away so much of the caloric, as not to leave enough to send the smoke up the upright chimney, depends upon the strength of the fire used and of the draught. Here we want the aid of more varied experience. When there is a tolerably good length of perpendicular rise from the stove, say nine or ten feet, before it takes the horizontal turn, and the chimney-shaft afterwards is also lofty, there is generally a better draught than where these perpendicular lines are short. But the draught improves very much in use; not only because

the whole line then becomes perfectly dry and heated, but because, when the flue gets coated with soot, it transmits the heat less freely, and it is, therefore, carried along the flue to a greater distance. The deposit of soot, as already observed, is extremely small, compared with that from other stoves; so little indeed, as not to require sweeping out more than once in five or six years; but it is enough to make a sensible difference in the transmission of heat through the pavement. However, if from this coating, or the thickness of pavement, the transmission of heat be retarded, it will continue to give warmth so much the longer after the fire is lowered or gone out, and the distribution of heat will be more equal. Caloric once set free by combustion will work its way to the general atmosphere, and the intermediate space is sure of the benefit of it sooner or later. Our business, however, is to confine the transmission as much as possible to the place where, and at the time when, it is wanted.

For the heating of churches, and all buildings having vaulted basements, if there were no obstructions, the whole pavement might be laid hollow, except about three feet next the outer walls. Nine-inch walls should be built for each straight course, leaving a space between them for a flue of from twelve to eighteen inches wide, and with a depth of twelve inches or more. The flue should be, as nearly as practicable, of one size or area throughout its horizontal course. The flue should go backward and forward, as shewn in the diagram. In a large building, it will, probably, be better to have two stoves, one by the side of the other: the flues for each side of the building to enter upright chimnies, near the opposite corners. At the end of the building, where the stoves are, opposite the nine-inch walls, which are shortened that the flue may turn round them, there must be soot doors. Where the building is large, and very large fires are used, it may be proper to have an under pavement of fire-stone, to the distance of fifteen or twenty feet from the stove. In common cases, fire-stones for eight or ten feet are sufficient. The cross joints of the paving stones must be well bedded in mortar, on slates or plates of cast-iron, a quarter of an inch thick, and nine inches wide. The straight joint must be bedded in the nine-inch wall with equal care, and the

sides and bottom of the flue must be smoothly pargetted. When the nine-inch walls stop short for the flue to turn back, the end should be finished with rounded bricks, such as are sometimes used for coping.

In churches and other large buildings, already built, where the whole pavement will not admit of being taken up, without more inconvenience and expense than is agreeable, or where the small distance between the crown of the arches and the pavement will only admit of flues in the spandrils—our plan must be modified to circumstances. We have done so at the County Fire Office, where the flue, in some parts, is not six inches deep; but if there be the means left to carry only a single flue, with its return, once up and down the middle of a church, I am certain it will diffuse more warmth, and of a better quality, than is obtained from the large cast-iron stoves with descending flues, now in use, with twelve times the consumption of fuel. It is not too much to say, that in a moderate sized house, every apartment may be rendered comfortably warm, through the pavement of the hall, from one fire in the basement. There needs no better warm air flue to the several rooms than the passage and staircase; still, the usual chimney openings and flues ought to be provided in every room, if only for the purpose of ventilation. The air in a close chamber soon becomes corrupted, by the change it undergoes when breathed, and by the ammoniacal gas which is emitted from the body. A frequent, if not constant, accession of fresh air is absolutely necessary to preserve the salubrity of the air we live in. Common open fire-places having a draught, are excellently adapted to carry off the impure air, the heavy carbonic acid gas—which hangs about the lower part of the room, along with the lighter ammoniacal and sulphureous corruptions which float above it. And the opening of the room door, from time to time, assists in driving the air within the room up the chimney, while it admits a fresh supply. In winter, the activity of the draught will be greatly promoted, by having a small fire in the grate:—in summer, if the draught perversely descends, and infects the chamber with the noxious smell of soot and carbonic acid gas, it may be set right by burning some paper or shavings *up* the chimney, and afterwards

burning a small lamp *there*. But the usual resource of opening the doors and windows, in that season, is generally the best remedy, if it can be applied.

The plan of warming the house at the County Fire Office is preferred to the Roman method, because the Fire Office method has been seen in use there, eight or nine years, with perfect success, and the Roman method has been laid aside nearly fourteen hundred years;—because it seems likely that the warmth may be more equally and effectually extracted from a fire draught, by conducting it backward and forward under a large pavement through a regular flue, than by allowing it to make its way from one point to another, across an open space, like an oven;—and because, upon the Roman method, a perfect and stuccoed pavement must cover that of the stones, to stop up the joints, and in this country we are not adepts in making stuccoed floors. However, it is very evident the Roman method was highly successful, or it would not have been adopted, as we find it to have been, in every country which fell under the Roman dominion. That classic lesson, and the method of the ingenious Chinese, are therefore well worthy of trial.

ADDENDA.

The following notices, extensively circulated by The County Fire Office, some years since, are not immediately connected with the subject of this work; but as they have a collateral bearing on it, and have been the means of saving several lives, their utility may be admitted as an excuse for introducing them in this place.

ACCIDENTS FROM THE FIRING OF WOMEN'S AND CHILDREN'S CLOTHING,

So frequently fatal, generally arise from the parties getting too near the fire, when clothed in muslin, chintz, or other light cotton dresses. The sudden opening of a door, occasioning a rush of air up the chimney, will frequently waft part of a dress in contact with the fire; an incautious turning round when standing before the fire often does the same thing; less frequently, a lighted coal darted from the fire, or a lighted candle carelessly used, are the cause of the accident.

Prevention.—It might be in vain to argue against clothing ladies and children in combustibles, if they are thought becoming; but persons so enveloped may be advised to beware of the fire. If they will sacrifice to the graces, let it be, not the risk of their lives, but the indulgence of hanging over the fire. A wire fire-guard lessens the danger from fire, but it is a troublesome appendage to the fire-place. Caution should be habitually observed when candles and light dresses are near to each other.

Cure.—When an accident does occur, do the direct contrary to what is usually done on such occasions. When a female discovers her dress to be on fire, she most frequently runs screaming about the room, and if no one is there to assist her, she opens the room door, and rushes to the head of the stairs for assistance. Nothing can be more fatally contrived to blow up the fire, and rapidly and fiercely envelope the sufferer in flames. The sufferer ought to avoid this running about as she would suicide. When she finds her clothes on fire, she ought to depend *on her screams, on pulling the bell, and on dropping on the floor:* if she can do so on a hearth-rug or loose carpet, and wrap it round her, the fire will be immediately extinguished. If there be not these things at hand, she

should turn over till the part on fire be undermost, and then press her clothes to the floor with her hands. If her clothes are on fire all round, she must turn over and over again. The portion of dress underneath her person, by pressure, will be extinguished, and the portion above it will burn feebly and harmlessly, compared to what it does when the sufferer is running about. If there be any one in the room, drop down as before: the assistant must then throw a carpet, rug, shawl, cloak, man's coat, or the like, over her, and press it closely, until the flame be extinguished.

The inflammation of a recent burn is surprisingly allayed by wrapping the part in cotton-wool, or wadding.

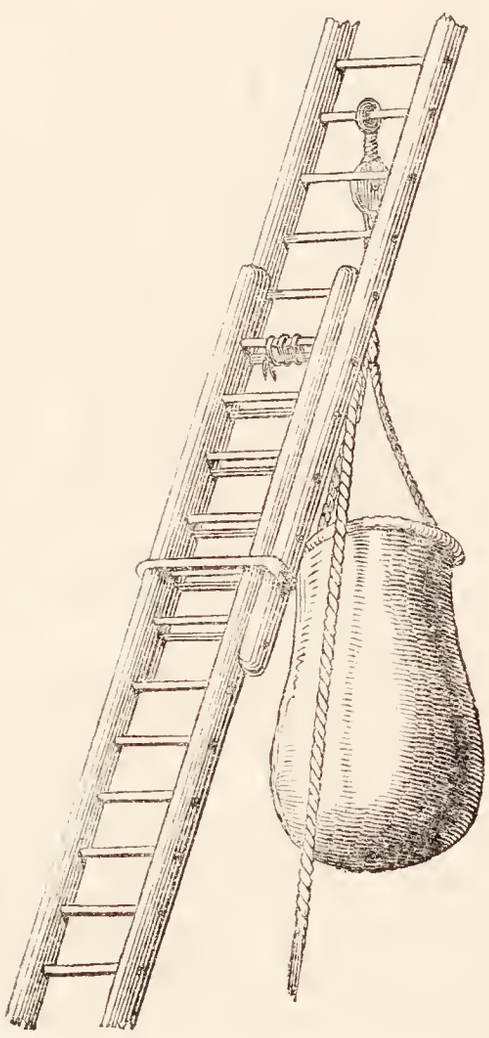
TO ESCAPE FROM THE UPPER CHAMBERS OF A HOUSE ON FIRE.

1st. By the Roof.—Every house ought to have easy means of access to the roof. If this be by a trap-door, it should be fastened with a bolt, which may be very easily pulled back; and steps or a ladder ought to be invariably on the spot. These things provided, if the house have a stone staircase, the means of escape (adjoining houses being accessible) may be relied on as certain; but if the staircase be of wood, the same dependance cannot be placed, for it is wonderful with what rapidity the staircase is on fire, frequently from bottom to top; and where the upper stairs are not actually on fire, the draught of fire and smoke from below is generally so considerable as to prevent escape by the roof.

2nd. By the Windows, *through means provided within.*—Considering how seldom, after all, lives are lost in houses on fire, few persons will be at the expense and trouble of providing a contrivance within their upper chambers, to descend therefrom in case of fire. Where their fears, however, are felt very strongly, or a building be exposed to a particular risk, there are many contrivances for the purpose, which may be kept always ready, folded up in a window-seat, or the like:—a rope ladder; a sort of wind-sail; a rope, with large knots like a bell rope, are among the most simple means provided.

3rd. By Means from Without.—This part of the subject deserves most attention. As no contrivance is suitable which does not admit of being almost immediately applied, it must be close at hand when an accident occurs; and therefore must be provided at hundreds of stations in such a place as London. The contrivance must neither be cumbrous, expensive, nor liable to get out of order; for it would be unreasonable to be at a great expense, or occupy valuable space, in contrivances against a remote risk; it must not be difficult to remove, or require any par-

ticular knowledge in application, for celerity and certainty of use by *any* persons who may be present, are essential to success. Systems of ladders to be raised by machinery, and to be removed on carriages, consequently are quite out of the question; none of these things have been found, or are likely, to answer in practice. The *common fire ladders are much to be preferred:* they are comparatively cheap, and are not liable to get out of order; they are hung up without occupying useful space; any one can move them, raise them, mount them, and assist sufferers in their escape. By law, each parish in London is required to be provided with three fire ladders; but it is necessary to have the means at hand of joining two ladders together. This is easily effected by a simple contrivance: the lower round of the short ladder is a rod of iron,—a bent strap of plate iron, a quarter of an inch thick, and one inch wide, swings from the projecting ends of this rod. It is so bent as to receive the end of the long ladder, which is run under the strap, between it and the rounds, until the top round coincides with the fifth round of the short ladder. These two rounds are then tied together with a piece of rope, or a pocket handkerchief, and the fastening is complete. This mode of fastening may be seen provided in the fire ladders against St. James's Church.



At the engine-house at the back of the County Fire Office, a contrivance is kept for facilitating the removal of persons from upper windows. It consists of a sack, four feet deep, kept open by a strong wooden hoop, two feet in diameter. A rope fastened to the opposite sides of this hoop is attached to a single rope, five-eighths of an inch thick, and seventy feet in length. This is run through a pulley, and the pulley has a spring hook, by which it may be suspended to an upper round of a ladder. The application is shewn in the figure. With this, a fireman might enter a window and place children, females, or infirm persons in the sack, who might be unable to descend a ladder. The thing is simple and portable; but, although it has been at hand ten years, no occasion has arisen to bring it into actual use.

4th. Keys of the Fire Ladders.—These should be kept at the nearest police station, always hung up in one place, with a bit of wood tied to the key, labelled "Fire Ladders." Similar keys should be kept by the policemen whose beat is next the ladders. The policemen ought to be examined frequently, to see that they have the keys with them. The regulations of the parish of St. James's, Westminster, leave nothing to be desired on this head:—

"Fire ladders are deposited in the following places, *viz.*—Against the wall of St. James's Church, next, Church Passage; against the wall of King Street Chapel, in Chapel Court; and at the Workhouse, in Poland Street. Keys are kept at the Watchhouse, the Workhouse, and with the respective policemen on duty nearest the ladders."

5th. Dropping from the Window.—If ladders be not procurable in time, this fearful alternative may be resorted to. On the first appearance of the necessity, persons outside should endeavour to procure a carpet, or a large counterpane, to receive the sufferer. Eight persons, or more, should get a firm hold of this round the edges, and keep it extended about three or four feet from the ground, by pulling outward, as from a centre, below the window from which the sufferer is to drop. If a bed, mattress, straw, or the like, can be procured to lay beneath the extended carpet, it will add to the security. If two sheets were tied together, by a reef or double knot, and one end were tied to the bed-post, or the leg of a table, pushed to the window, it might enable the sufferer to let himself down nearly twenty feet, from which the drop, in most cases, would be inconsiderable. The *first* tie should be to the leg of the table or bed-post, for even a single sheet will do something to lessen the drop; others may then be added, if time permit; but this requires a portion of time, activity, and resolution, which can seldom be found united on such occasions. If there be time to throw out a bed and mattress, and counterpane, and to beseech persons below to hold up

the latter, so much at least the sufferer should endeavour to do before he drop. If a carpet or counterpane be held extended below, children may be thrown out, with a rational hope of preservation. The room door should be kept shut, if possible.

The upper part of a room is frequently filled with smoke and flame, while the lower part is free : by creeping on his hands and knees, therefore, a man may go in or out of a room with safety, in which, if he walked upright, he could not breathe for an instant. The defence is made more complete by the man tieing his neckcloth or handkerchief over his mouth and nose.

THE END.

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